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14. ABSTRACT
This Test Operations Procedure (TOP) 07-1-003 covers the span of requirements and technologies that are unique to Unmanned Aircraft Systems (UASs). The role of a UAS is significantly different than that of a manned aircraft. The nominal operating altitudes and methods of employment for UASs provide for unique test challenges not encountered with manned aircraft. Many UASs are flown at significantly higher altitudes than manned aircraft creating unique test conditions. The increase in slant range and angular perspective from sensor to target needs to be considered for these new systems. Additionally the threat set for UASs in the Global War on Terrorism is very different than the traditional large mechanized threat set typically used for manned aircraft. A standard for sensor and target testing is required so that all sensors are tested to the same level of complexity. This TOP complements the overarching TOP (07-1-001) that is being generated.

15. SUBJECT TERMS
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TEST OPERATIONS PROCEDURE

Test Operations Procedure (TOP) 07-1-003 27 July 2010
DTIC AD No.

UNMANNED AIRCRAFT SYSTEMS (UAS) SENSOR AND TARGETING

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1. SCOPE.

This Test Operations Procedure (TOP) provides guidance for testing technical characteristics of sensors and targeting systems mounted on an Unmanned Aircraft System (UAS).

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

It is assumed that the ground support requirements for the UAS are addressed in other documents (Reference TOP 06-2-040[1*], 07-1-001[2]); consequently, the discussion of facilities should focus on the test range requirements. When testing sensors, the test coordinator should consider the amount of control over the ground space and air space, and any possible restriction associated with the area proposed for sensor testing. Systems utilizing forms of automatic detection or recognition systems require controlled ground space. Airspace must allow the UAS to maneuver within its designed operations envelope and restrictions with respect to radio frequencies, lasing, etc., must be considered.

2.2 Instrumentation.

There is a variety of instrumentation utilized during UAS testing to gather data. The data required should be dependent upon the Test and Evaluation Master Plan (TEMP) requirements, customer requirements, and test range requirements for safety and other purposes. Data requirements must be considered early in the test planning process to ensure the required instrumentation is available and used appropriately. Those responsible for data collection should be involved in test planning so they can consider and plan for instrument locations and requirements.

The ideal UAS sensor and targeting test data that needs to be gathered is depicted in Table 2.2-1. Reference TOP 07-1-001 for further details of required data.

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[*] Superscript numbers correspond to those in Appendix E, References.

TABLE 2.2-1. Sample UAS Instrumentation Data and Parameters	
Devices for Measuring	**Possible Error of Measuring Device**
Range Timing (IRIG-B or equivalent)	± 2 milliseconds
UAS Position	± 1 meter
Target Position	± 1 meter
Sensor Video (time tagged)	± 2 milliseconds
Operators Comments (time tagged)	± 1 second
Observation Calls (time tagged)	± 0.5 second
Meteorological Conditions:	
(a) Wind Speed	± 2 knots
(b) Wind Direction	± 2 degrees
(c) Temperature	± 2 degrees F
(d) Humidity	± 5 percent
(e) Atmospheric Transmittance	± 5 percent
(f) Scintillation	± 10 percent
(g) Solar Illumination	± 10 percent
(h) Lunar Illumination	± 10 percent
Laser Hit Point	± 0.2 meter
Sensor Resolution Target	± 5 percent
LEGEND: IRIG-B – Inter-Range Instrumentation Group UAS – Unmanned Aircraft System	

3. REQUIRED TEST CONDITIONS.

3.1 Test Documentation.

a. Strategy – The test coordinator shall review the TEMP, the System Specification, System Evaluation Plan, and any other applicable documents to determine a strategy for providing the required data for analysis.

b. Test Plan – The test coordinator shall develop a test plan based on the determined strategy that provides enough detail to efficiently execute the data collection. Distinct data collection efforts should be presented in individual subtests. The test plan must have sufficient detail that a particular subtest can be recreated after it is initially performed.

c. Test Card – The test coordinator should develop test cards that outline the specific events for a UAS sortie or a day's activities.

NOTE: TOP 07-1-001 references UAS required test conditions.

4. TEST PROCEDURES.

This section covers generic test procedures for several UAS sensors and targeting subtests. The procedural steps for the subtests represent a summary of the primary tasks required to evaluate sensors and target performance of a given UAS. TOP 07-1-001 contains procedures for general UAS subtests, including Hardware component testing, Software testing, Data Link and Communications testing, Range Safety testing, and Flight testing.

4.1 Sensor Tests.

4.1.1 Objective.

The objective of this subtest is to determine the baseline detection, recognition, and identification ranges against a man-size thermal, and a Color TV (CTV) Field Equivalent Bar Target (FEBT).

4.1.2 Test Procedures.

The sensor resolution test consists of determining the resolution range of stationary target boards. The instrumentation, targets, and test procedures planned for these resolution trials are outlined as follows:

a. Instrumentation. Data collection during resolution trials should be performed with the use of video recorders to record the sensor video, and a data recorder to provide Time, Space, and Position Information (TSPI) of the airborne platform. Range instrumentation should include a meteorological system for atmospheric documentation; temperature-calibrated infrared (IR) radiometers for documenting and validating IR target conditions, a spectrometer for validating CTV targets, and a range time system for data correlation.

b. Targets. As an example, the Forward-Looking Infrared (FLIR) and CTV targets should ideally be 1- by 1-meter, four-cycle targets. The FLIR target should ideally maintain a temperature delta of 1.25 degrees Celsius between the heated bars and the background. The CTV targets should ideally be painted to provide a 50-percent contrast between the bars and the background. A diagram of the target dimensions and a picture of example targets may be seen in Figure 4.1.2-1.

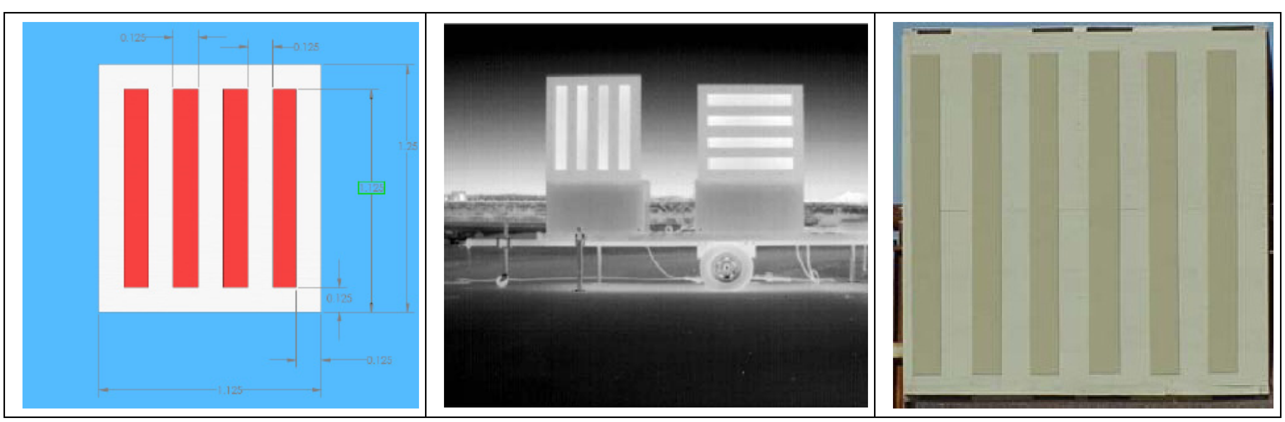

FIGURE 4.1.2-1. Example FLIR FEBT and Dimensions

c. Procedures. Resolution data should be obtained from both the recorded sensor video and the data collector's notes. Range truth data should be obtained from surveyed ground truth and testing should be conducted starting at large range the first day. The sensor Operator(s) should record their observations of the vertical and horizontal resolution targets. The UAS should approach the target until all Operators observe the FEBTs to be resolved.

In addition, transmitted video can be recorded and viewed by multiple Operators after the flight. The video must not be any further compressed, and the utilized downlink and video displays must be identical or equivalent to the actual downlink and display used in fielding. The targets should be set up at different ranges each day and all fields-of-view (FOVs) should be tested. Both horizontal and vertical resolution should be documented each day corresponding to a certain range.

(1) Each trial should begin with the target at a pre-determined range appropriate for the different FOVs, approximately 1.5 times the expected range to resolve the lowest-resolution (largest bars) target.

(2) The Operator should try to locate the target and optimize the displayed picture.

(3) Each Operator should observe the located FEBT of interest (Detection, Recognition, or ID) and watch the video until they can resolve the bars.

(4) Each day, this process should continue with the targets at different ranges and with all Operators participating in the data collection. Ideally, three Operators will be utilized during testing.

4.1.3 Data Required.

Section 5.1 outlines general test data required. The following additional data may also be collected during this phase of testing:

a. Vehicle position.

b. Target observation.

c. Range-to-target (kilometers) at observation.

4.1.4 Analysis.

All resolution calls should be made in real-time through utilization of the sensor display. Resolved ranges should be obtained by differencing the UAS position from the target position at the time the target bars are resolved for each target and each FOV.

Sensor video, observer comments, test team notes, and other data should be reviewed to validate all trials. No trials should be omitted unless significant rationale exists. Once the data have been reviewed and quality assured, run-by-run data should be compiled. Each trial conducted should be represented in a single row of a summary table containing all relevant information, such as the event time, range-to-target, and meteorological conditions.

The range data should also be scaled and scored against the Johnson criteria for man detection, man recognition, and man identification. The data should be presented as the 90-percent probability range for detection, recognition, and identification. Calculation of range performance using FEBT is found in ITOP 06-3-041[3], Field Measurement of DRI Ranges for Thermal Imaging Systems (Ground-Based Targets).

4.2 Probability of Detect and ID for Human and Vehicle Targets.

4.2.1 Objective.

The objective of this subtest is to determine the sensor's ability to detect and identify targets of various sizes. Detection and identification ranges for vehicles and personnel should be determined in this subtest.

4.2.2 Test Procedures.

The probability of detection (PD) and probability of identification (PID) for the Human and Vehicle Targets subtest should be executed to determine the ranges at which vehicle and personnel targets can be detected and identified. The instrumentation, targets and procedures for this subtest are as follows.

a. Instrumentation. Data collection during PD and PID trials should be performed with the use of video/audio recorders to record the sensor video and with a data recorder to provide TSPI of the UAS. Sensor video should be collected either on the UAS or at the ground station. If the data link compresses the video, the decompressed video should be collected at the ground station. Global Positioning System (GPS) packs should be located on all vehicles and personnel for true recorded TSPI data during all detection and identification calls. Range instrumentation should include the following: a meteorological system for atmospheric documentation; temperature-calibrated IR radiometers for documenting and validating IR target conditions; a spectrometer for validating the CTV targets; and, a range time system for data correlation.

b. Targets. Example targets and identification criteria are provided in Table 4.2.2-1.

TABLE 4.2.2-1. Example Targets and Identification Criteria

Detection Criteria	Criteria	Test Targets
The perception of an object of possible military interest but unconfirmed by recognition	Classify automobiles as SUVs, sedans or trucks.	SUVs, sedans, and trucks
The perception of an object of possible military interest but unconfirmed by recognition	Identify as armed or unarmed (two-handed hand-held weaponry).	Human

c. Procedures. This subtest consists of two test scenarios. The first test scenario should determine the performance of the sensor to detect and identify vehicle targets, while the second test scenario should determine the performance of the sensor to detect and identify human targets. Three observers should be used for all detection and identification events.

(1) Each trial should begin with a set of vehicles/persons at set fixed locations, separated by enough distance that even in the narrowest optical FOV targets are separated by at least two FOV widths. Only one given target should be viewable at a time.

(2) The UAS should fly towards the targets, with the flight path such that the FOV of the sensor reveals the detected targets. Detection trials should be performed using the sensor's widest FOV and identification trials should be performed using the sensor's narrowest optical FOV. Video should be recorded either on board or at the ground station. If sensor video recording is not available, observers should be at the ground station with a data recorder logging detection and ID calls. Multiple observers must be separate, which requires multiple runs.

(3) The time of the detection or identification call should be recorded, if live video is being used. If detection is being performed, the location in the scene should also be recorded. If identification is being recorded, the classification of the target should be recorded.

(4) A separate run should be made for each test, detection first in Wide Field of View (WFOV), followed by identification in Narrow Field of View (NFOV).

(5) This process should be repeated until the data requirement is completed.

An example of the PD and PID test matrix is provided in Table 4.2.2-2.

TABLE 4.2.2-2. Example EO/IR PD and PID Test Matrix

Test Point	Objective	Sensor	FOV	Targets	Observers	Total No. of Events
1	PD	EO	WFOV	20 Vehicle, 20 Human	3	120
2	PD	IR	WFOV	20 Vehicle, 20 Human	3	120
3	PID	EO	NFOV	20 Vehicle, 20 Human	3	120
4	PID	IR	NFOV	20 Vehicle, 20 Human	3	120

LEGEND:
EO – Electro-Optical
IR – Infrared
NFOV – Narrow Field of View
PD – Probability of Detection
PID – Probability of Identification
WFOV – Wide Field of View

4.2.3 Data Required.

Section 5.1 outlines general test data required. Section 4.1.3 contains additional data that may also be collected during this phase of testing.

4.2.4 Analysis.

All range resolution calls should be made using multiple observers viewing the recorded video or in real time through utilization of the sensor display. Resolution ranges should be obtained by differencing the UAS position from the target position at the time of the observation call. Summary statistics should be compiled to determine trends and identify any outliers. Sensor video, observer comments, test team notes and other data should be reviewed as necessary to validate all trials. No trials should be omitted unless significant rationale exists.

Once the data have been reviewed and quality assured, run-by-run data should be compiled. Each conducted trial should be represented in a single row of a summary table containing all relevant information such as the event time, range-to-target, FOV, sensor, and meteorological conditions.

The data should be presented as the 90-percent probability range for detection and identification for man and vehicle targets.

4.3 Geo-Location and Target Pre-Point.

4.3.1 Objective.

The objective of this subtest is to determine the geo-location accuracy (Target Location Error [TLE]) of the sensor for both target locates and target pre-point events. The purpose of the Target Pre-Point test is to determine the pre-point accuracy of a target sensor suite in the best navigation mode. Pre-pointing consists of inputting predetermined target coordinates into the navigation system and the UAS should direct its sensor to that point. Pre-pointing is the capability of a sensor system to be slewed to a predetermined location. For example, a target location can be transferred from the ground to a UAS. The UAS sensor can be pre-pointed to the target, acquire the target and continue with the follow-on targeting task.

4.3.2 Test Procedures.

4.3.2.1 Test Procedures for Target Location Accuracy Subtest.

All static targets should be surveyed and all moving targets should be instrumented with GPS to provide ground truth for each event. Pre-point accuracy data can be collected in conjunction with Target Locate tests. Previously surveyed Vertical Reference Target (VRT) boards are used as pre-point targets and all trials are conducted at the same range to target.

a. Instrumentation. Data collection during target designation trials should be performed with the use of UAS and range instrumentation. Range instrumentation should include GPS for targets and UAS, a meteorological system for atmospheric documentation, Mission Control for data recording and in real-time screening, and a range time system for data correlation and time tagging. UAS instrumentation should include recording of sensor video and embedded metadata.

b. Targets. Tactical and civilian vehicles should be positioned in surveyed locations for the duration of the data collection for this subtest. All moving targets that are used for the target locate events should be instrumented with GPS.

c. Procedures. The following generic procedures should be used:

(1) Perform boresight verification on the ground prior to every launch.

(2) Perform all normal sensor pre-launch checks in accordance with (IAW) the manufacturer's operator's manual.

(3) Set up targets per test matrix.

(4) Perform target locate events on specific targets designated by Mission Control.

(5) Track target.

(6) Arm and Fire laser.

(7) Mission Control records target coordinates and reported range.

(8) Repeat Step 4 as required by the test matrix.

An example of the target geo-locate test matrix can be seen in Table 4.3.2.1-1.

TABLE 4.3.2.1-1. Example Geo-Location Test Matrix

Test Point	Objective	Sensor	FOV	Target	Repetitions/ Observer	Total No. of Events
1	Geo-Locate	EO	TBD	Vehicle	5	TBD
2	Geo-Locate	EO	TBD	Target Board	5	TBD
3	Geo-Locate	IR	TBD	Vehicle	5	TBD
4	Geo-Locate	IR	TBD	Target Board	5	TBD

LEGEND:
EO – Electro-Optical
FOV – Field of View
IR – Infrared
No. – Number
TBD – To Be Determined

4.3.2.2 Test Procedures for Pre-Point Subtest.

Pre-point accuracy data should be collected in conjunction with Target Locate events. Previously surveyed VRT boards should be used as pre-point targets.

a. Instrumentation. Data collection during target designation trials should be performed with the use of UAS and range instrumentation. Range instrumentation should include GPS, a meteorological system for atmospheric documentation, Mission Control for data recording and in real-time screening, instrumentation cameras for documenting and recording target conditions, a range time system for data correlation. Instrumentation should include recording of sensor video and metadata.

b. Targets. Four 8- by 8-feet (ft) VRT boards that are located at various points should be surveyed prior to test.

c. Procedures. The following generic procedures should be used:

(1) Perform all normal pre-launch checks IAW the manufacturer’s operating manual.

(2) Perform an automatic boresight (if applicable).

(3) Set up targets per test matrix.

(4) Perform pre-point. Start in the narrowest FOV and step out to the widest, documenting the FOV in which the target can be seen. Record the corresponding slant range to target for each event.

(5) Repeat Steps 3 and 4 as required by test matrix.

An example of the target pre-point test matrix can be seen in Table 4.3.2.2-1.

TABLE 4.3.2.2-1. Example Target Pre-Point Test Matrix

Test Point	Objective	Sensor	FOV	Target	Repetitions/ Range	Total No. of Events
1	Target Pre-Point	EO	TBD	VRT	5	TBD
2	Target Pre-Point	EO	TBD	VRT	5	TBD
3	Target Pre-Point	IR	TBD	VRT	5	TBD
4	Target Pre-Point	IR	TBD	VRT	5	TBD

LEGEND:
EO – Electro-Optical
FOV – Field of View
IR – Infrared
No. – Number
TBD – To Be Determined
VRT – Vertical Reference Target

4.3.3 Data Required.

Section 5.1 outlines general test data required. Section 4.1.3 contains additional data that may also be collected during this phase of testing.

4.3.4 Analysis.

For Target Locate Analysis, the reported target coordinates contained within the metadata and the ground truth target coordinates should be differenced, and errors should be reported as horizontal and vertical target locate errors.

For Pre-Point Analysis, the probability of successful pre-point should be calculated by dividing the number of pre-points that fall in the selected FOV by the total number of pre-points attempted in that FOV.

4.4 Laser Designation Accuracy.

4.4.1 Objective.

Laser designation capabilities are generally evaluated in three separate areas: designation accuracy, boresight repeatability, and boresight retention.

Designation accuracy observes the system's ability to accurately place the laser hit point at the center of the desired target. The system aligns, via boresight, the laser designator to the center of optics. A designation trial can be conducted using either manual track (Operator in the loop) or automatic track. Automatic track requires the Operator to establish a quality track on the target and then to enable the automatic track mode. When in the automatic track mode, the system maintains the track on the target without Operator assistance. In at least the beginning stages of the automatic track mode, the center of optics is centered in the tracker gates. Sub-modes of the automatic tracker can include offset tracking and can be enabled at this point but are not typically used during the designation trials. Testing usually requires a series of 20- to 30-second designations in which all the laser pulses hit points are scored (typical AGM-114 flight times).

For boresight repeatability, most systems tested typically have an automatic boresight module which allows the alignment of the laser designator to the center-of-optics to be performed in the field. This capability is tested to ensure consistent performance between multiple automatic boresight alignments. Testing of the automatic boresight module is done in conjunction with laser designation accuracy testing but requires additional trials to be performed for several automatic boresight adjustments. The collected data are annotated to distinguish which of the automatic boresight adjustments was used, and a comparison between the various adjustments is conducted to examine the consistency between adjustments.

Boresight retention is the ability of the laser designation system to maintain its accuracy over an extended period of time. The time duration is usually defined in the system specification and usually is relative to the amount of mission time planned for the system. An initial boresight alignment is performed at the beginning of the test period, and then designation trials are conducted at intervals through-out the test period. The changes in the designation accuracy over time are used to assess the boresight retention. The instrumentation and test procedures used to perform the evaluation in these areas are outlined below. Changes in altitude may lead to changes in temperature, which affects boresight retention; therefore, these tests should be conducted at different altitudes.

4.4.2 Test Procedures.

a. Instrumentation. Data collection during target designation trials should be performed with the use of the instrumented test range and the system under test (SUT) data.

Required information from the SUT includes a record of target tracking during the designation trial (display video), the mode of the tracker (manual or automatic) and laser designator mode used (i.e. Pulse Repetition Frequency). If possible, the SUT should be instrumented to provide this information via sensor video and an avionics bus. The preferred method is to use a combination of on-board and down-linked recorded data. In addition, a vehicle tracking system for determining the SUT actual position is required.

Range instrumentation may include the vehicle tracking system; a meteorological system for atmospheric documentation, Mission Control for data recording and in real-time screening, instrumentation cameras for documenting and recording target conditions, a range time system for data correlation, laser target board and a video-based system to score the laser (e.g. the Video Based Laser Scoring System (VBLSS)).

b. Targets. Three sample laser designation targets for stationary target trials are currently available for use. The video-based system to score the laser (e.g. VBLSS) target is an example of the primary target used for helicopter-borne sensor systems. The sample VBLSS target is oriented upright and is an 8-meter high by 17-meter long permanent target board, has a 2.3- by 2.3-meter center tracking target. It also has four surveyed calibration markers for geospatially referencing pixel position in each video frame for laser spot position calculations. The large target size provides a larger background-to-target ratio, which offers more optimum tracking conditions.

The target should be painted to meet specific contrast requirements (tracking target-to-target background) for TV tracking, and the tracking target should be thermally controlled to provide a high contrast-aiming target for thermal tracking. Figure 4.4.2-1 provides a photograph of a sample VBLSS designation target.

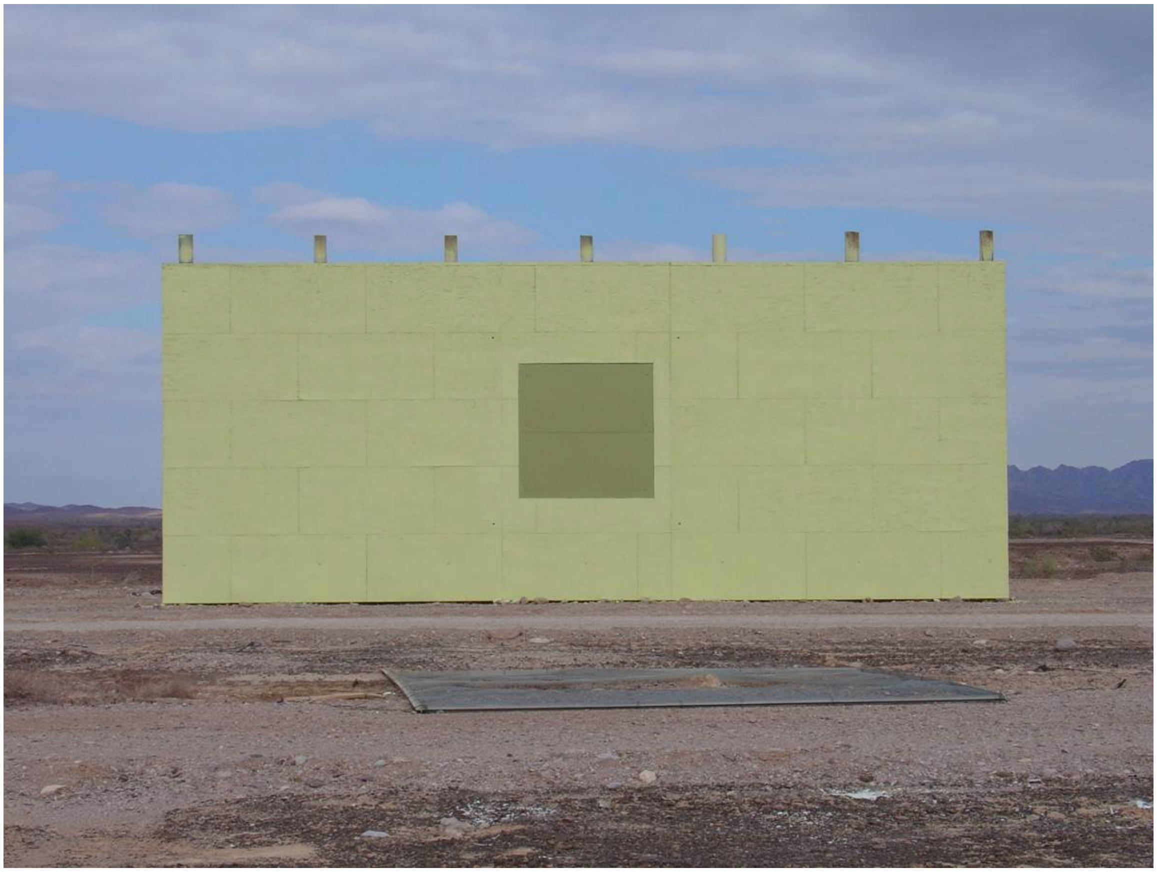

FIGURE 4.4.2-1. Sample VBLSS Laser Designation Target

The second example target utilized is a tilted video-based system to score the laser (e.g. "Maverick") target. This target is used when the airborne sensor system is operated at high altitudes. The sample target is swept back 30 degrees from a vertical orientation to facilitate the larger look-down angle, is 9.1 by 27.4 meters, and has a 2.3- by 2.3-meter center tracking target. The sample target also has four surveyed calibration markers for geospatially referencing pixel position in each video frame for laser spot position calculations (see Figure 4.4.2-2). Similar to the example 1 VBLSS target, the tilted video-based system to score the laser (e.g. Maverick) target should be painted to meet specific contrast requirements (tracking target-to-target background) for TV tracking, and the tracking target should also be thermally controlled to provide a high contrast-aiming target for thermal tracking. Figure 4.4.2-2 provides sample photographs of a Maverick designation target.

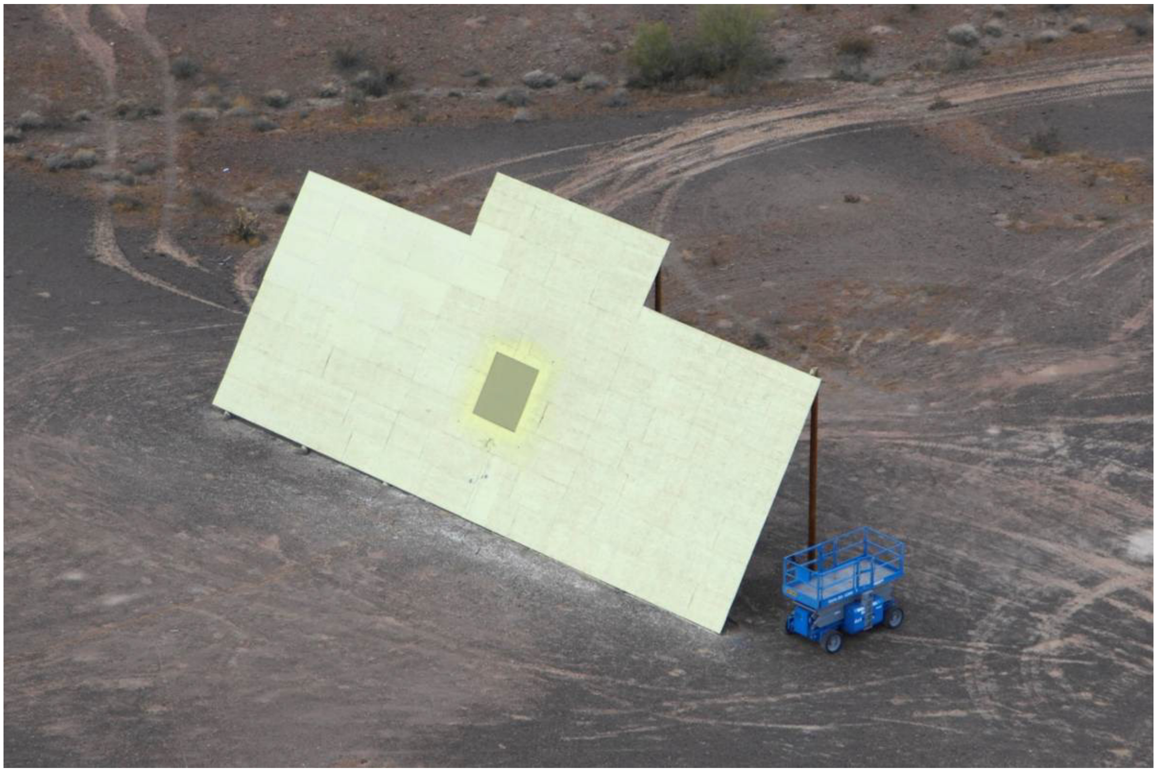

FIGURE 4.4.2-2. Sample Tilted Maverick Laser Designation Target

The third example target utilized is the moving VBLSS target. This target should be used to analyze the designation performance against moving targets. The target can be oriented all the way from vertical to horizontal which facilitates both high and low altitude airborne lasers. The sample target is 7.3 meters square, has a 2.3- by 2.3-meter center tracking target, and has four surveyed calibration markers for geospatially referencing pixel position in each video frame for laser spot position calculations. Similar to the VBLSS and the tilted Maverick target, the moving VBLSS target should be painted to meet specific contrast requirements (tracking target-to-target background) for TV tracking, and the tracking target should also be thermally controlled to provide a high contrast-aiming target for thermal tracking. Figure 4.4.2-3 provides a photograph of a sample moving VBLSS designation target.

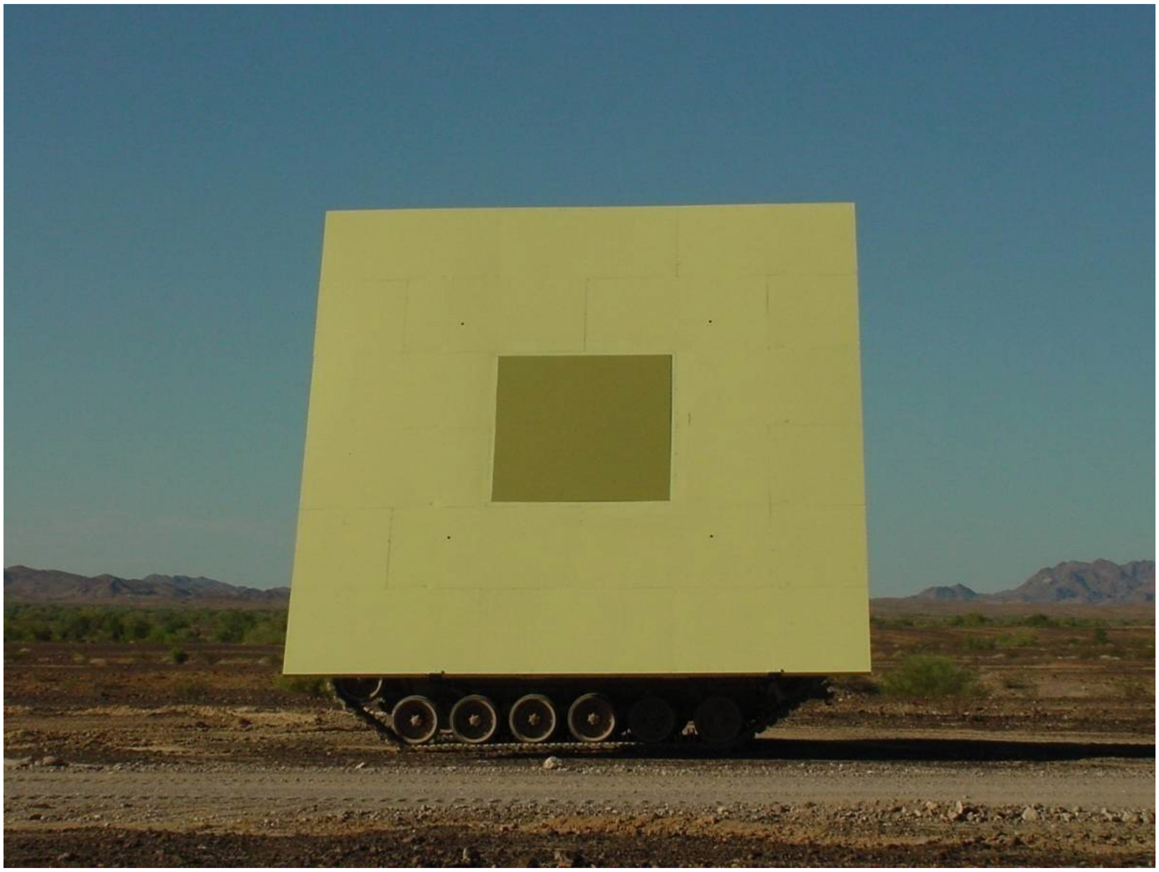

FIGURE 4.4.2-3. Sample Moving VBLSS Laser Designation Target

c. Procedures. During all designation trials, the UAS should be positioned at pre-determined ranges relative to the target. Depending on the requirements, the UAS should hover at 150 to 200 ft above ground level (AGL) or higher. Once in position, the Observer should lock on the target using Image Auto Track (IAT) or manual track using the appropriate sensor, and then should continuously designate the target for 30 seconds. Proper measures should be taken for non-hovering and fixed wing UAS regarding run-in line and elevation. The flight path should be based on specifications of a predetermined range. The UAS should designate while flying toward and away from the target, as well as laterally with the target to the right and to the left of the UAS to demonstrate the full range of the system. If an IAT break-lock occurs during designation, the trial should be documented and reinitiated. VBLSS or a similar system records the laser spot position on the target with respect to the target reference point (i.e. aim point/desired impact point) to provide a measure of total pointing error. The Observer should break lock and reacquire the target after each designation. The test matrices and generic procedures for each area of designation testing are outlined as follows.

(1) Perform all normal sensor preflight checks IAW the UAS operator’s manual.

(2) Perform internal boresight IAW the UAS operator’s manual.

(3) Transition the test UAS to test area (sample Figure 4.4.2-4).

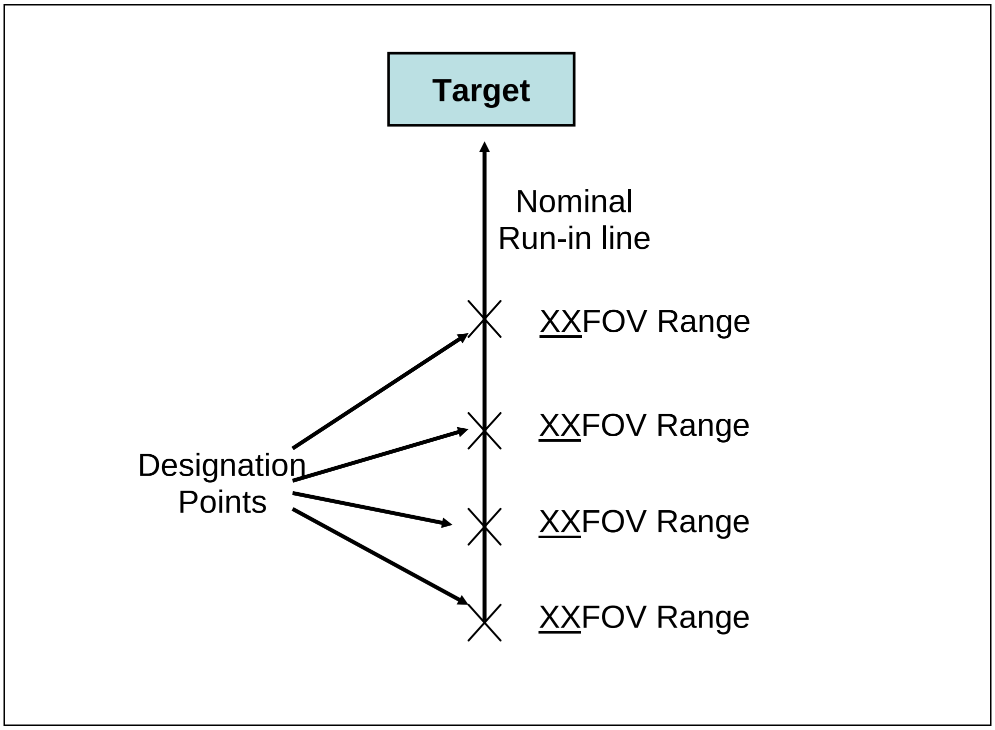

FIGURE 4.4.2-4. Sample Laser Designation Setup

(4) Set up UAS per test matrix and position UAS at range required by the sample test matrix (Table 4.4.2-1).

(a) Perform an auto-boresight, as required by the sample test matrix (Table 4.4.2-1).

(b) Acquire target board.

(c) Verify target crew is ready for data collection.

(d) Begin countdown to engagement.

(e) Designate target for a minimum of 30 seconds. VBLSS (or similar system) operators should confirm that data collection is adequate and call for the end of the engagement.

(f) Break lock on the target. Move the sensor line of sight (LOS) off of the target.

(g) Repeat *(a)* through *(f)* as required by the test matrix.

TABLE 4.4.2-1. Sample Laser Designation Accuracy and Boresight Repeatability Test Matrix

Test Point	Sensor	UAS Maneuver	CACTIS Target	Track Mode	Auto Boresights	Designations per AB	Total
LD-1	FLIR	Hover	Stationary	Auto	10	10	100
LD-2	CTV	Hover	Stationary	Auto	10	10	100
LD-3	FLIR	Hover	Moving	Auto	5	5	25
LD-4	CTV	Hover	Moving	Auto	5	5	25
LD-5	FLIR	S-turns	Stationary	Auto	5	5	25
LD-6	CTV	S-turns	Stationary	Auto	5	5	25
LD-7	FLIR	Hover	Stationary	Manual	2	5	10
LD-8	CTV	Hover	Stationary	Manual	2	2	10

NOTES:
1. All trials should be conducted at the same designation range for each sensor, in a designated FOV.
2. Designations should be for 30 seconds.
3. The Moving Target is traveling at tactical speeds or speeds IAW LD requirements documentation.

LEGEND:
AB – Auto Boresight
CACTIS – Compacted Automated Centroid Target Instrumentation System
CTV – Color Television
FLIR – Forward-Looking Infrared
FOV – Field of View
LD – Laser Designation
UAS – Unmanned Aircraft Systems

4.4.3 Data Required.

Section 5.1 outlines general test data required. The following additional data may also be collected during this phase of testing:

a. Sensor type (IR, Electro-Optical [EO] etc)

b. FOV select

c. Tracker mode and polarity select

d. Observation call

e. Range-to-target (kilometers) at observation

4.4.4 Data Analysis.

Data Analysis for the Laser Designation Accuracy subtest outlines the topics in Section 4.4.1. For designation accuracy, report the system's ability to accurately place the laser hit point at the center of the desired target with the use of the gathered VBLSS or similar system data. For boresight repeatability, analyze data collected to distinguish which of the automatic boresight adjustments was used and compare between the various adjustments to examine the consistency between adjustments. The changes in the designation accuracy over time should be used to assess boresight retention over a specified duration. A sample Laser Designation Accuracy subtest analysis is located in Appendix C.

4.5 Target Tracking.

4.5.1 Objective.

The IAT test determines a systems functional tracker performance. It also determines the ability of multiple Operators to track vehicle and personnel while actively using the sensor.

4.5.2 Test Procedures.

Depending on the IAT system, there are numerous track modes and scenarios. A designation trial can be conducted using either manual track (Operator in the loop) or automatic track. Automatic track requires the Operator to establish a quality track on the target and then enabling the automatic track mode. When in the automatic track mode the system maintains the track on the target without Operator assistance. Each mode and scenario should be tested to assure functionality as well as to determine which configuration is best for certain real-world scenarios.

The IAT is very important because it affects almost every subtest procedure. Most subtests require some type of steady lock on a target to gather accurate test data. In some cases, specific target tracking capacity requirements are established for the system. For example, tracker tenacity could be a capability requirement to keep a track on a target or re-acquiring a target if the tracker breaks lock on a target. In general, a tracker should not break lock on a target during maneuvering of the UAS.

This test should emphasize the collection of target tracking data against a primary target while using realistic scenarios. The instrumentation, targets and procedures for this subtest are as follows:

a. Instrumentation. Data collection during this subtest should be performed with the use of video/audio recorders to document the sensor video and a data recorder to provide TSPI of the UAS. GPS packs should be located on all vehicles and personnel for more accurate recorded TSPI data during all tracking events. Range instrumentation should include the following: a meteorological system for atmospheric documentation; temperature-calibrated IR radiometers for documenting and validating IR target conditions; a spectrometer for validating CTV targets; and, a range time system for data correlation.

b. Target. Civilian and/or military vehicles and human activity should be used as targets of interest for all tracking events.

c. Procedures. As an example, a total of ten observers should be used for this data collection. The procedures for this subtest are as follows:

(1) The sensor operator should be given coordinates to pre-point the target of interest.

(2) The target should move out at tactical velocities through natural obscurations and turns.

(3) The Operator should continue to track the target until the end of the event or until the sensor loses track of the target.

(4) The Operator should continue these procedures until the data collection is complete.

An example PD and PID test matrix is defined in Table 4.5.2-1.

TABLE 4.5.2-1. Example Vehicle and Personnel Tracking Test Matrix

Test Point	Objective	Sensor	FOV	Target	Repetitions/ Observer	Total No. of Events
1	Track	EO	TBD	Vehicle	20	200
2	Track	EO	TBD	Human	20	200
3	Track	IR	TBD	Human	20	200
4	Track	IR	TBD	Human	20	200

LEGEND:
EO – Electro-Optical
FOV – Field of View
IR – Infrared
No. – Number
TBD – To Be Determined

4.5.3 Data Required.

Section 5.1 outlines general test data required. Section 4.4.3 contains additional data that may also be collected during this phase of testing. Observation accuracy (correct, incorrect) data can also be collected.

4.5.4 Analysis.

The mission video recording should be the primary source of data for these test events. After each mission, the video should be reviewed and scored for the number of successful and failed events. Tracking success should be presented as percent success with relation to function of target type, range, and sensor (EO/IR).

4.6 Activity Monitoring.

4.6.1 Objective.

The objective of this subtest is to determine the ability of the system to monitor activities of vehicles and personnel.

4.6.2 Test Procedures.

The Operational Assessment of the system should consist of running tactically correct vignettes for scoring and observation. Vignettes should not be disclosed outside of the test organization in order to maintain integrity of the test. The instrumentation, targets, and test procedures planned for example trials are outlined as follows:

a. Instrumentation. Data collection during activity monitoring trials should be performed with the use of video/audio recorders to document the sensor video, data logs and a data recorder to provide TSPI of the UAS. GPS packs should be located on all vehicles and personnel for ground truth data during all applicable activities. Range instrumentation should include the following: a meteorological system for atmospheric documentation; temperature-calibrated IR radiometers for documenting and validating target conditions; and, a range time system for data correlation.

b. Targets. Examples of targets and identification criteria can be seen in Table 4.6.2-1.

TABLE 4.6.2-1. Example Targets and Identification Criteria

Detection Criteria	Identification Criteria	Test Targets
The perception of an object of possible military interest but unconfirmed by recognition	Identify automobiles as SUVs, sedans or trucks.	SUVs, sedans, and trucks
The perception of an object of possible military interest but unconfirmed by recognition	Identify limbs (e.g., arms, legs) on an individual.	Human
The perception of an object of possible military interest but unconfirmed by recognition	Identify cargo (e.g., shovels, rakes, ladders) in an open-bed, light-duty truck.	Shovels, pick axes, brooms, RPG, human wearing Battle Dress Uniform (BDU), and human wearing civilian clothing.

c. Procedures. Example test procedures include the following:

(1) Use an EO/IR Wide day-night sensor to monitor pre-designated area(s) of interest for the selected time frame. A surrogate customer should deliver an intelligence brief to the sensor team pre-mission. The mission brief should include descriptions of types of events that should be scored and intelligence information “gathered” over the last 24 hours. Simulated target activity vignettes of varying complexity and length should be run.

(2) Next, execute simulated target activity vignettes during activity monitoring mission. Specifics on these vignettes should be withheld from test documents to protect the integrity of the test. Depending on the system's Concept of Operations and capabilities, the vignettes executed should contain activities from the following categories and levels of difficulty that should be evaluated and scored to reveal measures of system performance. Activity categories are defined in increasing order of difficulty of identification (highest sensor resolution required) as High (H), Medium (M) and Low (L).

(a) Suspected threat emplacement site arrivals and departures:
<u>1.</u> Vehicle arrival and stop (L)
<u>2.</u> Personnel dismount (M)
<u>3.</u> Device emplacement (M/H)
<u>4.</u> Material recognition (H)

(b) Cache site arrivals and departures:
<u>1.</u> Vehicle arrival and stop (L)
<u>2.</u> Personnel dismount (M)
<u>3.</u> Material pick-up or drop-off (M/H)
<u>4.</u> Material identification (H)

(c) Coordination meeting arrivals and departures:
<u>1.</u> Multiple vehicle interaction (L)
<u>2.</u> Personnel interaction (M)
<u>3.</u> Material transfer (M/H)

(d) Vehicle motion/stop:
<u>1.</u> Number of vehicles (L)
<u>2.</u> Target location (L)
<u>3.</u> Target activity (L)
<u>4.</u> Target track (L)
<u>5.</u> Directional changes (L)

(e) Vehicle loading/unloading:
<u>1.</u> Target location (L)
<u>2.</u> Target track (L)
<u>3.</u> Target activity (M/H)

(f) Vehicle off-road travel:
<u>1.</u> Target location (L)
<u>2.</u> Target track (L)
<u>3.</u> Target activity (M/H)

(g) Personnel off-road dismount activity:
<u>1.</u> Equipment emplacement (M/H)
<u>2.</u> Disturbed earth (H)
<u>3.</u> Equipment interaction/usage-cell phone, weapons, GPS, cameras, Improvised Explosive Devices, objects on ground, etc. (H)

(h) Erratic or evasive vehicle maneuvering:
1. Frequent starts and stops (L)
2. Frequent off-road activity (L)
3. Vehicle avoidance (M)
4. Non-uniform speed (M)

(i) Disturbed earth/change detection:
1. Holes/debris (M/H)
2. Equipment emplacement (M/H)

(j) Threat Launch and/or Detonation:
1. Target location (L)
2. Blast estimate (M)
3. Reverse time line activity forensics (M/H)

(3) Direct system to alternate collection areas per vignettes, as required. A surrogate customer should give direction from the ground. These directions should include new mission specifics based on "new intelligence."

(4) Monitor area for suspicious activity, acquire and track targets as required.

(5) Cue EO Narrow and/or IR sensor for target ID.

(6) Report target activity (location, activity type, target type, and time) to surrogate customer.

(7) Transmit motion imagery of target.

(8) Spot Report (SPOTREP), both initial and amended, and mission data to the necessary authorities post-mission.

4.6.3 Data Required.

Section 5.1 outlines general test data required. The following additional data may also be collected during this phase of testing:

a. Observation call

b. Time of intelligence product delivery to surrogate commander

c. Range-to-target (kilometers) at observation

4.6.4 Analysis.

All scoring criteria were derived from the sample National Imagery Interpretability Rating Scale (NIIRS) criteria described in Appendix A.

4.7 SAR Tactical Target Detection.

4.7.1 Objective.

The objective of this subtest is to determine the detection performance of the Synthetic Aperture Radar (SAR) with the radar resolution set appropriately for detection. Also, additional data should be collected with the radar resolution at a higher setting.

4.7.2 Test Procedures.

For the majority of the SAR tactical target detection events, the UAS should have standoff ranges that vary. Example flight profiles can be seen in Figure 4.7.2-1. Targets should be set up in target positions that maximize the data collected for each flight.

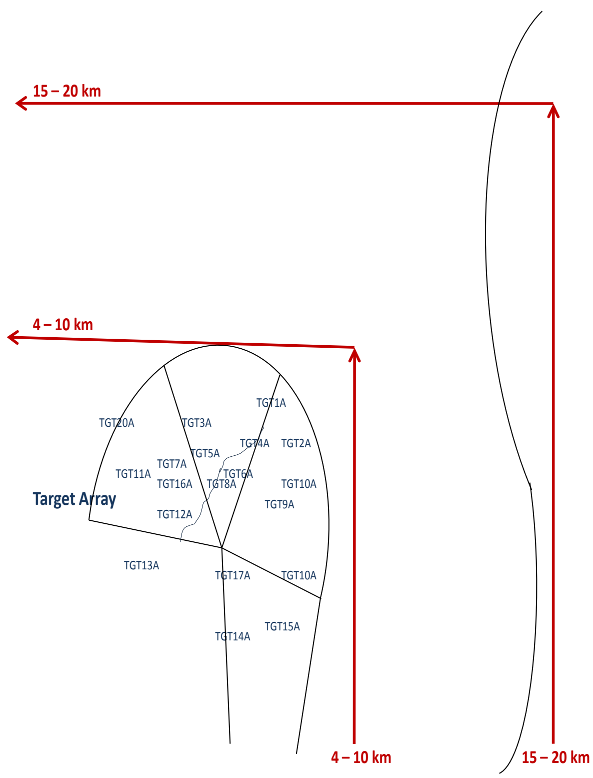

FIGURE 4.7.2-1. Example SAR Flight Profiles

During the target detection events, the SAR should primarily be set to appropriate resolution and mode for detection events. Additional data should be collected in a higher radar resolution as a secondary objective to this subtest. The instrumentation, targets and test procedures for the SAR data collection are as follows:

a. Instrumentation. Data collection during tactical target classification trials should be performed with the use of on-board UAS or ground instrumentation. Range instrumentation should include the following: TSPI; a meteorological system for atmospheric documentation; Mission Control for data recording and in real-time screening; a range time system for data correlation; and, a sensor control workstation that should record digital imagery and embedded metadata such as range mode, sensor select, polarity, coordinates, and time. All collected imagery must comply with standard imagery formats such as NTSC, NIFT, or STANAG 4607.

b. Target. For this subtest, a static target array with 17 to 25 possible target locations should be used. For each mission, a pre-determined number of different targets should be shuffled between the target locations in the array. Example targets for this subtest are as follows: T-72, BMP, BTR-70, M-60, D-30, a Technical Truck, Tactical Operations Center (TOC), and civilian vehicles. An example of the array of target locations for data collection can be seen in Figure 4.7.2-2.

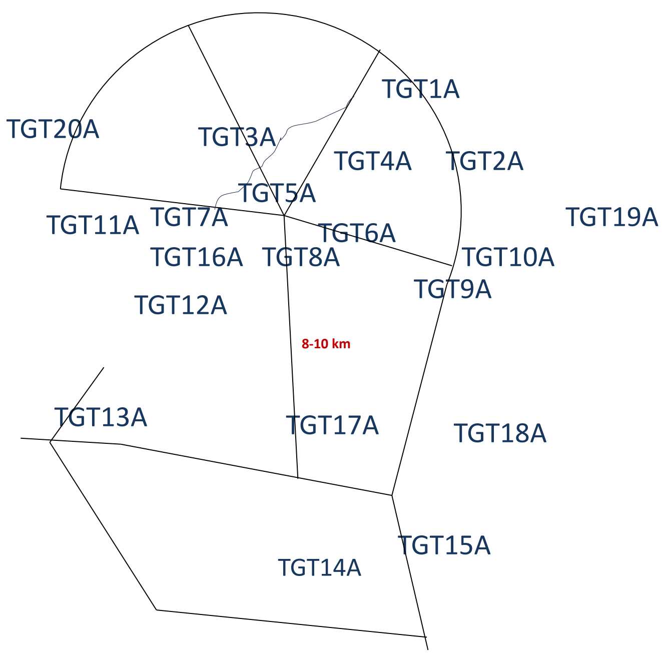

FIGURE 4.7.2-2. Example SAR Target Array

c. Procedures. The test procedures should be executed to determine the SAR detection capabilities. This imagery should be collected at altitudes banding operational altitudes. The flight profile should allow for a variety of targets and multiple stand-off and slant ranges. These ranges should be selected to determine the threshold and objective performance while exercising a variety of slant ranges and depression angles during the radar data collection. If time permits, excursion profiles should be flown to measure the minimum and maximum effective ranges of the system.

The focus for the target detection subtest should be to collect imagery on a variety of tactical targets at multiple ranges.

The following generic procedures should be used for each test trial:

(1) Perform all normal SAR system preflight checks IAW the UAS operator's manual.

(2) Transition the test UAS to the test area.

(3) Set up the UAS per test matrix for detection data collection.

(4) Data Collection:

(a) Set the resolution of the SAR to appropriate resolution and mode.

(b) The Operator uses surveyed grid coordinates to determine area of interest for detection data collection.

(c) Execute SAR image collection for detection event.

(d) Repeat steps (*a*) - (*c*) until all mission objectives are accomplished. An example of mission objectives can be seen in Table 4.7.2-1.

TABLE 4.7.2-1. Example SAR Tactical Target Detection Planned Test Points					
Mission ID	**Objective**	**Altitude (ft AGL)**	**Radar Mode**	**Radar Resolution (m)**	**No. of Targets Interrogated**
1	PD	8,000	SAR (strip)	1	20
2	PD	12,000	SAR (strip)	1	20
3	PD	16,000	SAR (strip)	1	20
4	PD	20,000	SAR (strip)	1	20
5	PD	8,000	SAR (strip)	0.3	20
6	PD	12,000	SAR (strip)	0.3	20
7	PD	16,000	SAR (strip)	0.3	20
8	PD	20,000	SAR (strip)	0.3	20

NOTE: All 0.3-meter resolution trials should be executed as a secondary objective.

LEGEND:
AGL – Above Ground Level
ft – feet
ID – identification
m – meter
No. – number
PD – Probability of Detection
SAR – Synthetic Aperture Radar

4.7.3 Data Required.

Section 5.1 outlines general test data required. The following additional data may also be collected during this phase of testing:

a. Radar operational mode (SAR)

b. SAR operational mode (strip or spot)

c. Radar resolution

d. UAS GPS unit number

e. Target GPS unit numbers

f. Reported UAS Inertial Navigation System (INS) XYZ coordinates

g. True UAS Height Above Target (HAT)

h. True UAS X, Y coordinates Universal Transverse Mercator (UTM)

i. UAS heading (not flight direction)

j. True target X, Y coordinates (UTM)

k. Reported target X, Y coordinates (UTM)

l. Outcome

4.7.4 Analysis.

The collected data should be processed and converted to standard imagery files such as NTSC, NIFT, or STANAG 4607. Experienced SAR image analysts (Soldiers) should be shown each image and given time to classify the target. A detected target should be considered correct if the observer clicks on a pixel within a given buffer zone of the actual target location proportional to the size of the target.

The results should be binned in 500-meter wide bins (stand-off range) to reduce experimental noise. It is not anticipated that there should be an equal amount of calls in each bin. The probability versus slant range and standoff range results should be reported showing the number of calls per bin in a “bubble” chart. The false alarm rate should also be presented.

4.8 SAR Tactical Target Classification.

4.8.1 Objective.

The objective of this section is to determine the classification performance of the SAR.

4.8.2 Test Procedures.

SAR target classification imagery should be collected utilizing the same target array, ranges, flight profiles, and altitudes as the Tactical Target Detection Subtest. During all target classification events, the SAR should be set to classification resolution and operate in the spot mode. One round-trip of each profile per altitude should provide the data necessary for this evaluation. The instrumentation, targets, and test procedures for the SAR classification events are as follows:

a. Instrumentation. Data collection during tactical target classification trials should be performed with the use of on-board UAS or ground instrumentation. Range instrumentation should include the following: TSPI; a meteorological system for atmospheric documentation; Mission Control for data recording and in real-time screening; a range time system for data correlation; and, a sensor control workstation that should record digital imagery and embedded metadata such as range mode, sensor select, polarity, coordinates, and time. All collected imagery must comply with standard imagery formats such as NTSC, NIFT, or STANAG 4607.

b. Target. The same targets, target locations and flight profiles should be used for both the detection and classification subtests. Examples of the target array and flight profiles can be seen in Figures 4.7.2-1 and 4.7.2-2.

c. Procedures. The focus for the target classification subtest should be to collect imagery on a variety of tactical targets at multiple ranges.

The following generic procedures should be used for each test trial:

(1) Perform all normal SAR system preflight checks IAW the UAS operator's manual.

(2) Transition the test UAS to the test area.

(3) Set up the UAS per test matrix for classification data collection.

(4) Data Collection:

(a) Set the resolution of the SAR to appropriate resolution and mode for classification.

(b) Operator uses surveyed grid coordinates to determine area of interest for classification data collection.

(c) Execute SAR image collection for classification event.

(d) Repeat steps (*a*), (*b*) and (*c*) until mission objectives are accomplished. An example of mission objectives is presented in Table 4.8.2-1.

TABLE 4.8.2-1. Example SAR Tactical Target Classification Planned Test Points

Mission ID	Objective	Altitude (ft AGL)	Radar Mode	Radar Resolution (m)	No. of Targets Interrogated
1	PC	8,000	SAR (spot)	0.3	20
2	PC	14,000	SAR (spot)	0.3	20
3	PC	20,000	SAR (spot)	0.3	20

LEGEND:
AGL – Above Ground Level
ID – identification
ft – feet
m – meter
No. – Number
PC – Probability of Classification
SAR – Synthetic Aperture Radar

4.8.3 Data Required.

Section 5.1 outlines general test data required. Section 4.7.3 contains additional data that may also be collected during this phase of testing.

4.8.4 Analysis.

The collected data should be processed and converted to a standard image file format such as NTSC, NIFT, or STANAG 4607. Trained observers (soldiers) should be shown each image and given time to classify the target. They should be presented with the eight classification choices; one of which is the correct classification of the target in the scene.

The eight classification categories include:

a. Wheeled Vehicles

b. Tracked Vehicles

c. Aviation Fixed Wing

d. Aviation Rotary Wing

e. CMD and Staff

f. ADA and AAA

g. Radar

h. ARTY

The results should be binned in 500-meter wide bins to reduce experimental noise. It is not anticipated that there should be an equal amount of calls in each bin. The probability versus slant range and standoff range results should be reported for each target classification type showing the number of calls per bin in a “bubble” chart.

4.9 SAR Target Location Error.

4.9.1 Objective.

The objective of this subtest is to determine the performance accuracy of the horizontal and vertical target locate function for the SAR.

4.9.2 Test Procedures.

The test procedures should be executed to determine the target locate capabilities. Recorded data within the SAR images should be used to perform the TLE Analysis. The instrumentation, targets, and test procedures for the target locate events are outlined as follows:

a. Instrumentation. Data collection during TLE trials should be performed with the use of on-board UAS or range ground instrumentation. Range instrumentation should include the following: TSPI; a meteorological system for atmospheric documentation; Mission Control for data recording and in real-time screening; a range time system for data correlation; and, a sensor control workstation that should record digital imagery and embedded metadata. All collected imagery must comply with standard imagery formats such as NTSC, NIFT, or STANAG 4607.

b. Target. No additional data collection should be necessary for the TLE Analysis. The same targets, target locations and flight profiles that should be used for the detection and classification subtests should also be utilized for this analysis.

c. Procedures. The SAR images used for the TLE data should be collected in the detection and classification subtests. Refer to Paragraphs 4.7.2 and 4.8.2 for those procedures. An example of test points for the TLE analysis is shown in Table 4.9.2-1.

TABLE 4.9.2-1. Example SAR TLE Planned Test Points

Mission ID	Objective	Altitude (ft AGL)	Radar Mode	Radar Resolution (m)	No. of Targets Interrogated
1	TLE	8,000	SAR (strip)	1	20
2	TLE	12,000	SAR (strip)	1	20
3	TLE	16,000	SAR (strip)	1	20
4	TLE	20,000	SAR (strip)	1	20
5	TLE	8,000	SAR (strip)	0.3	20
6	TLE	12,000	SAR (strip)	0.3	20
7	TLE	16,000	SAR (strip)	0.3	20
8	TLE	20,000	SAR (strip)	0.3	20
9	TLE	8,000	SAR (spot)	0.3	30
10	TLE	14,000	SAR (spot)	0.3	30
11	TLE	20,000	SAR (spot)	0.3	30

NOTE: TLE data are embedded within the detection and classification images.

LEGEND:
AGL– Above Ground Level
ID – identification
ft – feet
m – meter
SAR – Synthetic Aperture Radar
TLE – Target Location Error

4.9.3 Data Required.

Section 5.1 outlines general test data required. Section 4.7.3 contains additional data that may also be collected during this phase of testing.

4.9.4 Analysis.

All target position data for the TLE events are embedded within the SAR images that are collected during the SAR tactical target detection and classification subtests. Because of this, the data collected during those subtests can be utilized to perform the analysis for this subtest.

The SAR detection data and classification data should be independently evaluated for TLE. Recorded X and Y coordinates and slant ranges of the target location of interest for all SAR detection and classification events should be used. These reported coordinates should be compared to surveyed target location truth to calculate the TLE (X and Y).

For each target locate executed, the corresponding UAS coordinates (X, Y and Z) should be extracted from the images or files. The UAS X, Y and Z for the corresponding events should be compared to the TSPI UAS truth to calculate the radar INS error. The UAS horizontal error (X and Y) and vertical error (Z) should be reported as a possible TLE contributor.

4.10 Ground Moving Target Indicator Detection/Target Location Error.

4.10.1 Objective.

The objective of this test is to determine the detection, false alarm rate, and TLE performance for the radar system in Ground Moving Target Indicator (GMTI) mode. The purpose of the Target Location is to acquire the location of a target and the test will determine the target locate accuracy of the UAS sensor in the best navigation mode. The Target Location Accuracy test incorporates a few systems. For instance, the UAS reports range to target which must be checked with target ground truth. The UAS depends on highly efficient, dependable, and accurate navigation system to provide the operator with precise grid coordinates.

4.10.2 Test Procedures.

The test procedures should be executed to determine the GMTI detection capabilities of the Radar System. GMTI data collection altitudes should bound the expected operational altitudes of the system. The targets and test procedures for the GMTI events are outlined as follows:

a. Instrumentation. Refer to Paragraph 2.2 for the instrumentation.

b. Targets. During the GMTI test flights, four to six vehicles should be used to create a moving target array. The vehicle array should continuously drive along predetermined roads and all vehicle paths should be separated by a minimum of 1 kilometer in radial distance to avoid target confusion. All vehicles should remain in radio contact with the test officer. Vehicles may be civilian or military. An example of vehicle routes consisting of four civilian pick-up trucks and one tracked vehicle is depicted in Figure 4.10.2-1.

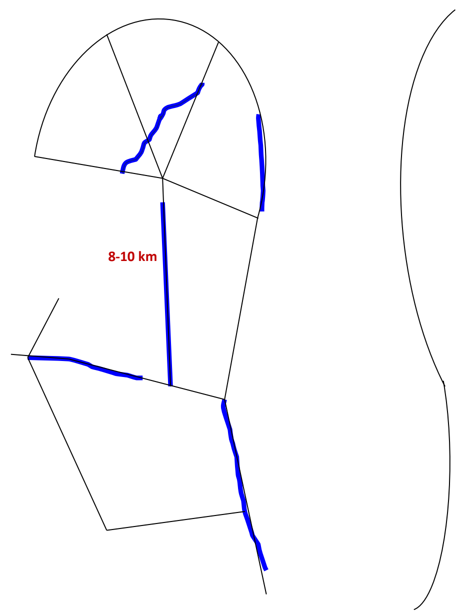

FIGURE 4.10.2-1. Example GMTI Target Routes (blue)

c. Procedures. For the majority of the GMTI events, the UAS should begin collecting data on as many moving vehicles as possible at a time. The test area should be controlled with road blocks. If possible, the controlled area should be at least 16 kilometers by 16 kilometers. Any target detections outside of this area should be ignored. An example of the flight profiles for GMTI procedures can be seen in Figure 4.10.2-2. The following generic procedures should be used for each test trial:

(1) Perform all normal Radar System preflight checks IAW the UAS operator's manual.

(2) Transition the test UAS to the test area.

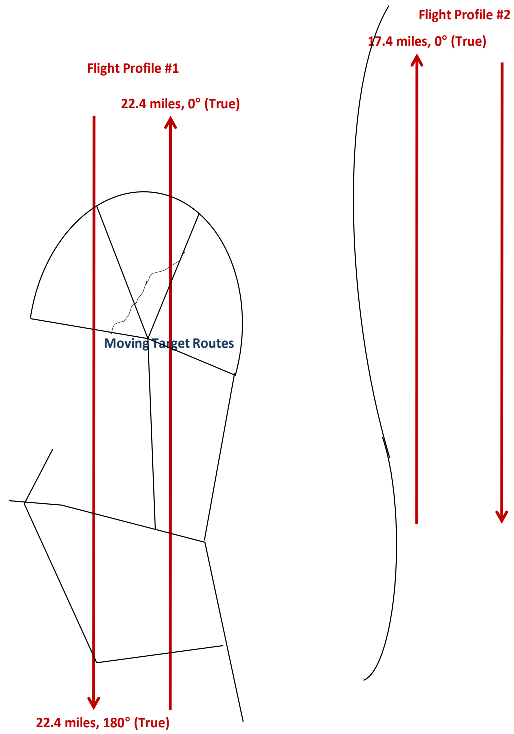

FIGURE 4.10.2-2. Example GMTI Flight Profiles

(3) Set up the UAS per test matrix for GMTI data collection.

(4) Set the GMTI to the appropriate mode IAW the system operator's manual.

(5) Continuously perform GMTI scans when target vehicles are in the radar field of regard until mission objectives are completed. Table 4.10.2-1 contains examples of mission objectives.

TABLE 4.10.2-1. Example GMTI PD and TLE Planned Test Points					
Mission ID	**Objective**	**Altitude (ft AGL)**	**Radar Mode**	**Target Speed (kph)**	**No. of Targets within a Scan**
1	PD	8,000	GMTI	55-70	45
2	PD	14,000	GMTI	55-70	45
3	PD	20,000	GMTI	55-70	45
4	PD	8,000	GMTI	40-55	45
5	PD	14,000	GMTI	40-55	45
6	PD	20,000	GMTI	40-55	45
7	PD	8,000	GMTI	25-40	45
8	PD	14,000	GMTI	25-40	45
9	PD	20,000	GMTI	25-40	45
10	PD	8,000	GMTI	10-25	45
11	PD	14,000	GMTI	10-25	45
12	PD	20,000	GMTI	10-25	45
13	TLE	15,000	GMTI	All speeds	270
14	TLE	20,000	GMTI	All speeds	270

NOTE: ARC and Spot mode should be executed during the data collection with standoff ranges varying. If time permits, conduct at additional altitudes.

LEGEND:
AGL – Above Ground Level
ID – identification
ft – feet
GMTI – Ground Moving Target Indicator
kph – knots per hour
No. – number
PD – Probability of Detection
TLE – Target Location Error

4.10.3 Data Required.

Section 5.1 outlines general test data required. The following additional data may also be collected during this phase of testing:

a. Radar operational mode (SAR or GMTI)

b. Radar resolution

c. Radar return direction and speed

d. Radar azimuth and depression angles (degrees)

e. True target X, Y coordinates (UTM)

f. Reported target X, Y coordinates (UTM)

g. Target speed (kph)

h. Target direction

i. Target identity

j. Target GPS unit numbers

k. UAS GPS unit number

l. Reported UAS INS X, Y, Z coordinates

m. True UAS HAT

n. True UAS X, Y coordinates (UTM)

o. UAS heading (not flight direction)

p. Radar scan mode (ARC, Spot, etc)

q. Radar sensitivity/threshold

r. Outcome

4.10.4 Analysis.

Each GMTI radar scan should be logged into a log file. Based on the Field-of-Regard (FOR) for each scan, it should be determined how many true targets and false alarms were actually available. The true targets should be matched up with detection times from the GMTI reports. The reported detection coordinates should be compared to ground truth to determine a TLE for each event. The GMTI refresh rate should be measured and reported.

Only scans that have an instrumented target in the radar FOR should be analyzed. All detections that have a target position outside of the controlled area should be ignored. Any left over GMTI detections inside the controlled area, other than those accounted for, are false alarms. For the collected GMTI data, the corresponding target velocities should be binned in 5-kilometer per hour bins, and the probabilities of detection versus target velocities should be examined. GMTI detection performance should be analyzed against absolute and apparent (radial) target velocities separately. A Minimum Detectable Velocity (MDV) should be determined from the Analysis.

For TLE analysis, the log file’s reported target locate data should be compared to the nearest vehicle’s truth data (TSPI) at the time the target was reported in the metadata. TSPI values should be separated into corresponding standoff ranges (nadir to target) and then differenced to determine the error values for each Target Locate. Navigation data should be taken from UAS TSPI and metadata on board the UAS at the time of Target Locate to determine possible INS error influence on TLE.

4.11 SAR Resolution.

4.11.1 Objective.

The objective of this subtest is to determine the Minimum Resolvable Ground Sample Distance (MRGSD) and the Impulse Response (IPR) of the SAR.

4.11.2 Test Procedures.

The test procedures should be executed to determine IPR of the SAR System Processor and to determine the MRGSD of the Radar System. Imagery of the Corner Cube Reflectors (CCR) should be taken during the Tactical Target Detection and Classification subtests. The CCRs should be set at fixed surveyed target locations and oriented normal to LOS of the radar (example in Figure 4.11.2-1). The CCRs are triangular tetrahedral made in several different edge lengths, such as 1 meter or 30 centimeter edge lengths.

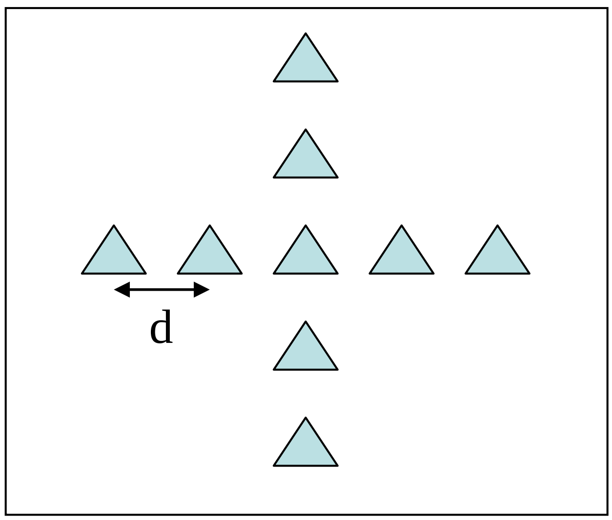

FIGURE 4.11.2-1. CCR Array

During the Sensor Resolution subtest, data should be collected with the SAR set to appropriate resolutions and modes for detection and classification for SUT.

a. Instrumentation. Data collection during sensor resolution trials should be performed with the use of on-board UAS or ground instrumentation. Range instrumentation should include the following: TSPI; a meteorological system for atmospheric documentation; Mission Control for data recording and in real-time screening; a range time system for data correlation; and, a workstation that should record digital imagery and embedded metadata. All collected imagery must comply with industry standard imagery formats such as NTSC, NIFT, or STANAG 4607.

b. Target. For resolution testing, triangular trihedral CCRs should be placed in the area of operations in two configurations to measure the objective resolutions. At least two different size CCRs should be used for this subtest.

c. Procedures. The same procedures for collecting the data for the SAR Tactical Target Detection should be followed for this subtest with CCRs substituted for tactical targets. The same standoff/slant ranges should be executed by flying the same flight profiles as flown in the SAR tactical target detection subtest. The IPR individual resolution settings should be determined by imaging one CCR with the corresponding edge length dimensions (i.e., if the SAR is set to 1.0 m resolution, the 1.0 m CCR should be imaged). The MRGSD for individual resolution settings should be determined by imaging an array (see Figure 4.11.2-1) of CCRs with the corresponding edge length dimensions for the specific resolution under test (i.e., if the SAR is set to 1.0 m resolution, the 1.0 m CCRs should be imaged).

The dimension, *d*, should be initially set to twice the size of the corner cube. This distance should be varied by each mission until the MRGSD can be determined. An example test matrix for the Sensor Resolution Planned Test Points is provided in Table 4.11.2-1.

TABLE 4.11.2-1. Example of Sensor Resolution Planned Test Points

Mission ID	Objective	Altitude (ft AGL)	Mode	Radar Resolution (m)	No. of CCRs in an Image
1	IPR/MRGSD Data Collection	8,000	SAR (strip)	1 (strip)	10
2	IPR/MRGSD Data Collection	14,000	SAR (strip)	1 (strip)	10
3	IPR/MRGSD Data Collection	20,000	SAR (strip)	1 (strip)	10
4	IPR/MRGSD Data Collection	8,000	SAR (strip)	0.3 (strip)	10
5	IPR/MRGSD Data Collection	14,000	SAR (strip)	0.3 (strip)	10
6	IPR/MRGSD Data Collection	20,000	SAR (strip)	0.3 (strip)	10
7	IPR/MRGSD Data Collection	8,000	SAR (strip)	0.3 (spot)	10
8	IPR/MRGSD Data Collection	14,000	SAR (strip)	0.3 (spot)	10
9	IPR/MRGSD Data Collection	20,000	SAR (strip)	0.3 (spot)	10

LEGEND:
AGL – Above Ground Level
CCR – Corner Cube Reflector
ID – identification
ft – feet
IPR – Impulse Response
m – meter
MRGSD – Minimum Resolvable Ground Sample Distance
No. – number
SAR – Synthetic Aperture Radar

4.11.3 Data Required.

Section 5.1 outlines general test data required. Section 4.10.3 contains additional data that may also be collected during this phase of testing. The following additional data may also be collected:

a. SAR operational mode (strip, spot, etc)

b. True target X, Y coordinates (UTM)

c. Reported target X, Y coordinates (UTM)

4.11.4 Analysis.

Each CCR and CCR array at each position should be imaged in spot mode and strip mode. The data collected from these runs should be analyzed to determine both the IPR and the MRGSD in each applicable resolution of the SAR processor.

4.12 Laser Rangefinder Accuracy.

4.12.1 Objective.

The Laser Rangefinder (LRF) accuracy test determines how effectively the LRF works. The LRF is essential in computing distances to targets for anything from the use of munitions to general points of reference. The LRF tests should produce the minimum and maximum distances from the target. Trials should be performed with the LRF set in the range-only mode or similar. In addition, LRF trials should be performed at various ranges to determine relative accuracy to actual UAS and target coordinates at the time of LRF designations. The actual coordinates can be retrieved from GPS or other means available to accurately portray the true UAS to target ranges.

4.12.2 Test Procedures.

a. Instrumentation. Data collection during target designation trials should be performed with the use of on-board UAS or range instrumentation. Range instrumentation should include the following: an instrumented vehicle tracking system (GPS); a meteorological system for atmospheric documentation; Mission Control for data recording and in real-time screening; instrumentation cameras (appropriate cameras need to be used to help verify rangefinder laser spot) for documenting and recording target conditions; and, a range time system for data correlation. UAS instrumentation includes recording of through-sight video and selected bus parameters.

b. Targets. An obscuration board should be used as the target for LRF accuracy trials. The obscuration board is a large target, painted to produce the proper reflectivity. A mesh target can be placed in front of the obscuration board for the resolution trials. A photograph of a sample obscuration board is provided in Figure 4.12.2-1. The sample target dimensions are 16 by 32 ft. A sample photograph of an obscuration board with a mesh target is provided in Figure 4.12.2-2.

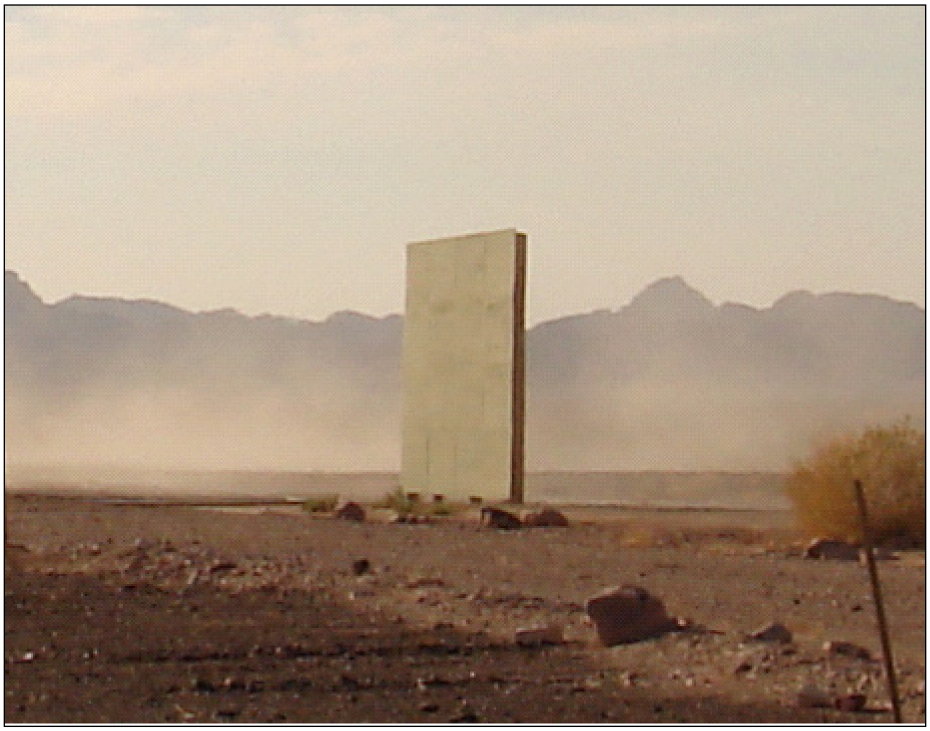

FIGURE 4.12.2-1. Sample Rangefinder Board

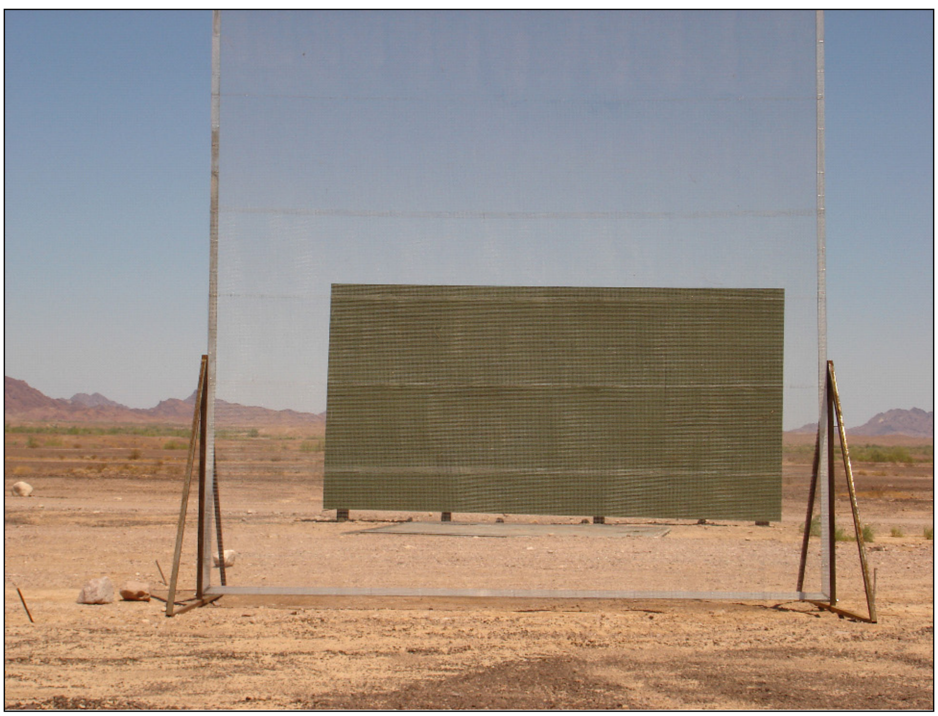

FIGURE 4.12.2-2. Sample Rangefinder Board with Mesh

c. Procedures. For sample Test Points LR-1, LR-2, LR-6, and LR-7, the UAS should be positioned at the maximum specification range from the target and then converged on the target and lased every 2 kilometers from a hover, switching back and forth between first and last pulse. At 2 kilometers from the target, the UAS incrementally will close on the target at 250-meter intervals. For sample Test Points LR-3 and LR-4, the UAS starts at maximum specification range then moves closer to the target at 30 knots while lasing in first pulse logic at 2-kilometer intervals. For sample Test Point LR-5, the UAS continuously lases from the maximum specification range to within 250 meters of the target. Table 4.12.2-1 provides a sample LRF accuracy test matrix.

TABLE 4.12.2-1. Sample Laser Rangefinder Accuracy Test Matrix

Test Point	Sensor	Purpose	Pulse Logic	UAS Maneuver	Target	Range	Repetitions/ Range	Total Trials
LR-1	FLIR	Accuracy	First/ Last	Hover	Stationary	Max to Min at 2Km Intervals	6 per 2Km Interval HPs	6 x # of 2Km Intervals
LR-2	CTV	Accuracy	First/ Last	Hover	Stationary	Max to Min at 2Km Intervals	6 per 2Km Interval HPs	6 x # of 2Km Intervals
LR-3	FLIR	Accuracy	First	30 kt	Stationary	Max to Min at 2Km Intervals	3 Passes	3 x # of 2Km Intervals
LR-4	CTV	Accuracy	First	30 kt	Stationary	Max to Min at 2Km Intervals	3 Passes	3 x # of 2Km Intervals
LR-5	FLIR	Accuracy	First	30 kt	Stationary	Range 2 to Min, Continuous Ranging	1 Pass	1 x # of Continuous Intervals
LR-6	FLIR	Resolution	First/ Last	Hover	Stationary w/Mesh	Range 2 to Min, Continuous Ranging	6 per 2Km Interval HPs	6 x # of 2Km Intervals
LR-7	CTV	Resolution	First/ Last	Hover	Stationary w/Mesh	Range 2 to Min, Continuous Ranging	6 per 2Km Interval HPs	6 x # of 2Km Intervals

NOTES:
1. All trials should be conducted at specification designation range for each sensor, in UNFOV.
2. Test matrix was conducted on three flights, two of which were in conjunction with Boresight Retention trials.

LEGEND:
- # – number
- CTV – Color Television
- FLIR – Forward-Looking Infrared
- HP Hover Point
- kt – knot
- Km – kilometer
- LR – Laser Rangefinder
- UAS – Unmanned Aircraft System
- w/ – with

4.12.3 Data Required.

Section 5.1 outlines general test data required. Section 4.4.3 contains additional data that may also be collected during this phase of testing.

4.12.4 Analysis.

UAS-to-target slant range data, as determined by Improved Vehicle Tracking System (IVTS) GPS, is the truth source for all rangefinder analysis. Lever-arm corrections should be applied to the IVTS GPS data to account for the physical difference between the IVTS GPS antenna location and the LRF/designator location. The time for each laser range is determined and differenced against the corresponding range truth source at the laser range time.

LRF accuracy should be analyzed from the difference between the recorded and truth range. Analyses for the resolution trials examine the difference between ranging in different pulse modes conducted with the mesh target in place.

4.13 Related/Associated Navigation.

4.13.1 Objective.

The purpose of this subtest is to determine if the navigation system is working correctly. The navigation system plays an important part in target in two primary ways:

The first role of the navigation system is to measure the UAS's attitude, which is critical for weapons targeting. The armament datum line is used as a reference for weapons and is usually parallel to the UAS center line. Fire control systems use the UAS's attitude to provide cueing and steering to weapons and sensor systems. If the weapon and sensor systems are mounted on the same platform, the relationship between the two are relative measurements.

The navigation system's other role is to keep track of where in absolute space the UAS is located, and to translate other absolute locations to UAS relative locations. This information becomes critical when attempting to target an object whose position was determined by a second system that is not part of the UAS, or when transferring targeting information to other platforms. To efficiently perform targeting, UAS position and the attitude must be accurately determined.

4.13.2 Test Procedures.

As a testing consideration, it can be difficult to determine attitude accuracy directly; therefore, the use of related data for other testing is often the best and only way to determine "associate navigation" performance. An item to consider is an independent truth source for UAS position for all targeting tests, e.g. Target Locate, Target Prepoint, etc. Another consideration of collected information is the navigation information for the IUT for all targeting tests.

a. Instrumentation. The instrumentation required for the navigation test must be capable of sensing, processing, storing, and/or transmitting a complete set of test data to an auxiliary ground-based recording station. Example instrumentation includes IVTS, NIDAR, or MPS 25 Radar for the use of true positioning.

b. Test Facilities. Refer to Section 2 for the test facility requirements.

4.13.3 Data Required.

The data required to evaluate the related navigation are the UAS truth source data and range-to-target along with target position and GPS UAS position information.

4.13.4 Analysis.

The data collected during this test event should be used to analyze the related navigation performance for a given UAS configuration by comparing the independent UAS truth source data and the test target information.

5. DATA REQUIRED.

5.1 General.

The following data are similar per subtest section and should be collected during testing:

a. Flight test number

b. Date and time of test

c. Mission type (technical target baseline, test point identification)

d. UAS/sensor configuration (software, hardware loads)

e. Test Observer(s)/Operator(s) and Aircrew identification

f. Target type/identity

g. Target position

h. GPS UAS position information

i. Time of observation call

j. Observer video

k. Observer(s) and Test Officer(s) comments/remarks

l. Meteorological conditions:

(1) Wind speed

(2) Wind direction

(3) Temperature

(4) Humidity

(5) Atmospheric transmittance

(6) Scintillation

(7) Solar illumination

(8) Lunar illumination

Due to the significant number of procedures in this TOP, other specific guidance for data required is covered within each associated test procedure section/paragraph.

5.2 Uncertainty Analysis.

The measurement uncertainty is the result of a number of systematic and random sources of error. These include, but are not limited to, the following: the environment, the measuring equipment, the test item itself and relevant assumptions made during the test program.

6. PRESENTATION OF DATA

Due to the significant number of procedures in this TOP, the specific guidance on presentation of data is covered within each associated test procedure section/paragraph.

APPENDIX A. SAMPLE NIIRS SCORING CRITERIA.

NIIRS SCORING CRITERIA

	LEVEL	DESCRIPTION	NIIRS
Agricultural Criteria	1	Detect large (i.e., greater than 100 acre) slash and burn clearings in jungle areas.	1.4
		Identify long-lot land ownership patterns along major waterways.	1.7
	2	Detect forest clearings in suspected coca growing areas.	2.4
		Detect windbreaks (i.e., rows of trees) between fields.	2.6
		Detect forest clearings in suspected opium growing areas.	2.7
	3	Identify the path of a tornado through crop fields.	3.3
		Detect small (e.g., less than 1 acre) forest clearings in suspected opium growing areas.	3.3
		Detect individual large buildings (e.g., house, barn) in a farmstead.	3.3
		Detect slash and burn field abandonment in a jungle through observation of re-growth.	3.3
		Distinguish between crop land and pasture land.	3.4
		Detect hay mowing.	3.5
		Detect mechanized grain harvesting operations.	3.6
	4	Detect active plowing of fields.	4.1
		Identify small water sources (e.g., stock ponds, prairie potholes) in range land areas.	4.2
		Distinguish between individual trees in an orchard.	4.4
		Distinguish between individual rows in a mature vineyard.	4.5
		Detect large farm equipment (e.g., tractors, combines) in open fields.	4.5
		Identify commercial greenhouses.	4.6
		Detect marijuana harvest based on the absence of vegetation in known marijuana fields.	4.8
		Detect vehicle tracks through freshly plowed fields.	4.8
	5	Detect individual large domesticated animals (e.g., horses, cattle) in grazing pastures.	5.3
		Detect small (i.e., less than 1-meter wide) irrigation/drainage ditches.	5.3
		Identify individual bales of hay/straw.	5.4
		Distinguish between livestock watering troughs and feed troughs in pastures.	5.7
		Distinguish between individual rows of truck crops.	5.7
		Distinguish between livestock semi-trailers and regular box-body semi-trailers.	5.8
		Identify ornamental tree nurseries.	5.8
	6	Detect a closed gate across a single lane road.	6.0
		Identify orchards by fruit type based on tree size and shape (e.g., apple, cherry, citrus).	6.1
		Determine the number of rows on a field crop (e.g., corn, soybean) planter.	6.3
		Detect mixed cropping in small farm plots.	6.4
		Distinguish between mature and immature coca fields.	6.5
		Detect coca harvest based on the absence of leaves on coca bushes in known coca fields.	6.6
		Identify cattle guards on single lane roads.	6.6
		Detect the presence of obstructions (e.g., weed growth, soil, stumpage) in an irrigation system.	6.6
		Detect manual coca plant eradication.	6.6
		Identify large farm animals by type (e.g., horses, cows).	6.7
		Identify tractor-drawn farm machinery by type (e.g., plow, sprayer, planter).	6.7
		Detect flowering of opium poppies in known fields.	6.7
		Count sheep or goats in a flock.	6.8
		Identify silage crops by type (e.g., corn, sorghum).	6.9
	7	Distinguish opium poppies from wheat in small plots.	6.9
		Identify medium farm animals by type (e.g., sheep, goats).	7.1
		Identify individual steel fence posts.	7.6
		Distinguish between ewes and lambs.	7.7
		Distinguish between individual tea and coffee plants.	7.9
	8	Identify an uncoiled garden hose lying on the ground.	8.2
		Identify specific type of truck crop being grown (e.g., tomatoes, peppers, lettuce).	8.2
		Detect scoring of poppy bulbs.	8.5
		Detect tubing (approximately 1-inch diameter) for drip irrigation systems.	8.5
		Civil NIIRS Reference Guide	

	LEVEL	DESCRIPTION	NIIRS
Cultural Criteria	1	Detect lines of transportation (either road or rail, but do not distinguish between).	1.3
		Detect major highway and rail bridges over water (e.g., Golden Gate, Chesapeake Bay).	1.7
		Detect multi-lane divided highways (e.g., greater than four lanes).	1.9
		Detect a golf course.	1.9
	2	Identify major street patterns in urban areas.	2.3
		Identify large POL storage tanks.	2.5
		Identify individual city blocks in a metropolitan area.	2.6
		Identify large buildings as multi-wing.	2.7
		Detect a dual lane/track bridge over water.	2.7
		Detect large area groundbreaking or clearing for construction of new facility or expansion of existing facilities.	2.7
		Identify vessels of ~300' length by type (e.g., merchant, combatant) at a known port.	2.8
		Detect rail yards of six or more tracks.	2.9
		Detect two-lane improved roads.	2.9
		Detect large UAS (e.g., Boeing 737, Airbus A-300, MD-80) at a major commercial airport.	2.9
	3	Detect two-lane unimproved roads.	3.0
		Detect cleared security strip around a sensitive facility.	3.1
		Detect trail clearing/cutting in forested areas.	3.1
		Detect land-based oil exploration activity (e.g., bore-holes/spoils, seismic survey traces) in an arid environment.	3.2
		Identify an off-shore oil exploration drilling vessel.	3.3
		Detect indications of underground mining activity (e.g., headworks, tailings, rail spurs).	3.3
		Detect new oil drilling sites in or near a known oil field.	3.3
		Distinguish between roads with single and multiple lanes.	3.3
		Identify a road as divided or undivided.	3.3
		Detect very large vehicles (e.g., tractor-trailers).	3.3
		Detect major breaks in lines of communications (e.g., collapsed bridges, washed out roads, inundation) due to natural disasters.	3.3
		Detect a nuclear reactor containment structure.	3.3
		Count all large free-standing smokestacks and/or cooling towers at major power plants.	3.3
		Detect rows of automobiles in a parking lot.	3.4
		Detect single rail cars on rail sidings.	3.5
		Detect fixed-wing UAS at a dirt or grass airstrip.	3.5
		Detect control tower at airfield.	3.5
		Detect slag heaps at a mineral processing plant.	3.5
		Identify individual greens on a golf course.	3.6
		Distinguish between individual rail cars in a train.	3.7
		Detect an automobile.	3.7
		Identify a small (e.g., less than 1/4 acre) electrical transformer yard in a residential neighborhood.	3.8
		Detect towers associated with power lines.	3.8
		Detect guard towers along perimeter fences.	3.8
	4	Identify potential secondary fire sources (e.g., fuel storage areas, explosive storage area).	4.1
		Detect a security fence at an urban industrial facility.	4.1
		Detect barriers/obstacles (e.g., barrels, logs) on runways.	4.2
		Detect groups of cargo (e.g., crates, pallets) on piers and quays.	4.2
		Detect fallen trees obstructing two-lane roads.	4.4
		Distinguish between locomotives and railcars.	4.7
		Detect external structural damage to urban buildings from natural disasters.	4.7
		Identify a pump house at an above ground POL (petroleum, oil, lubricant) storage area.	4.7
		Identify trucks as cab-over-engine or engine-in-front.	4.7
		Detect an individual concrete barrier/obstacle (e.g., dragon's teeth, Jersey barrier).	4.8

	LEVEL	DESCRIPTION	NIIRS
Cultural Criteria	5	Identify raw materials (e.g., lumber, sand, gravel, bricks) in a residential construction area.	5.0
		Identify individual lines painted on paved roads, aprons, parking lots.	5.1
		Distinguish between wheeled and tracked vehicle tracks.	5.1
		Identify large construction equipment by type (e.g., bulldozer, backhoe, road grader).	5.2
		Identify individual telephone/electric poles in residential neighborhoods.	5.4
		Identify fallen utility poles. (NIIRS 5.5)	5.5
		Detect lines on track, basketball, volleyball, tennis, baseball, soccer playing areas.	5.5
		Identify individual 55 gallon drums in an open storage facility.	5.7
	6	Detect individuals, when not in a group.	6.2
		Identify pole-mounted electrical transformers in residential neighborhoods.	6.4
		Detect small road signs (e.g., stop, yield, speed limit) in an urban area.	6.6
		Identify building materials of urban structures (e.g., brick, wood, concrete, stucco, tile, adobe).	6.8
		Identify flags on a green at a golf course.	6.9
	7	Identify individual above ground utility lines in a residential neighborhood.	7.1
		Identify a manhole cover.	7.1
		Identify a fire hydrant.	7.2
		Identify limbs (arms, legs) on an individual.	7.3
		Distinguish between welded and riveted joints on large POL tanks.	7.6
		Identify riveting or seams on locomotives.	7.6
		Identify bicycle details (e.g., frame, wheel/tire, etc.).	7.7
		Detect outside rearview mirrors on passenger cars.	7.7
		Identify farm or construction tools by general shape (e.g., shovel, pitchfork, pick, ax, sledgehammer).	7.9
		Identify individual asphalt shingles on a residential roof.	7.9
		Count ceramic insulators on individual transmission wires at a switching yard.	7.9
	8	Identify valve locations along a small (~3") pipe.	8.0
		Detect corrosion on metal surfaces.	8.1
		Identify small hand tools (e.g., hammer, carpenters saw, pipe wrench).	8.1
		Identify hazardous material labels on crates and barrels.	8.1
		Identify the registration on pleasure craft in port.	8.1
		Determine the direction of flow through a pipe based on flow arrows.	8.2
		Identify facial features on an individual (i.e., at least partial discrimination of some facial features).	8.2
		Identify a cellular phone antenna on a passenger car.	8.2

	LEVEL	DESCRIPTION	NIIRS
Natural Criteria	1	Identify abandoned meander sections in major river flood plains.	1.4
		Detect large area (e.g., greater than 100 acres) timber clear cutting.	1.7
		Identify an inland delta, based on braided channels and oxbows.	1.8
		Detect large coastal sand beaches.	1.8
	2	Distinguish between islands and nests of moored ships.	2.2
		Detect utility towers in forested regions on the basis of a sequence of circular clearings.	2.7
	3	Identify general vegetation cover type (e.g., grass, brush, wetland, agricultural crop) in non-forested areas.	3.1
		Detect jeep trails.	3.3
		Identify small slash and burn agriculture plots (e.g., <1 acre).	3.5
		Identify inland waterways navigable by medium boats (e.g., 30' cabin cruiser).	3.5
		Detect small (e.g., less than 1 acre) man-made clearings in a forested area.	3.5
		Distinguish between open and closed forest canopies.	3.5
		Detect landslide or rockslide large enough to obstruct a single lane road.	3.6
		Distinguish between operational and abandoned quarries.	3.7
	4	Detect jeep trails in scrub brush.	4.1
		Distinguish between islands and mats of aquatic vegetation.	4.1
		Identify cable logging operations.	4.1
		Detect individual truck tracks through grassy vegetation.	4.3
		Detect vertical obstruction (e.g., tree, shrub, snag) in vegetated helicopter landing zones.	4.3
		Identify log decks (i.e., stacks of recently cut logs).	4.4
		Detect jeep trails crossing bare soil areas.	4.5
		Detect fallen trees in inland waterways.	4.9
	5	Identify hummocks in marsh/swamp.	5.0
		Detect selective timber harvest.	5.0
		Detect foot trails through grassland.	5.1
		Detect small marine mammals (e.g., harbor seals) on ice floes.	5.1
		Detect small water sources (e.g., springs, seeps) in arid areas.	5.2
		Distinguish individual trees in a closed canopy deciduous forest.	5.3
		Identify prairie dog towns based on soil disruption pattern.	5.4
		Detect evidence of a fish kill (e.g., masses of floating fish).	5.5
		Identify tree species on the basis of crown configuration.	5.5
		Detect large game (e.g., deer, antelope, elk, and moose) in a meadow.	5.6
	6	Detect natural objects (e.g., tree stumps, large rocks, boulders) in forest clearings and open fields.	6.2
		Distinguish between hummocks and stands of aquatic grass/cattails in marsh/swamp.	6.3
		Distinguish between pulp, pole, and saw timber in single species plantation stands.	6.3
		Detect schools of dolphins (e.g., Bottlenose, Dahl) in coastal waters.	6.5
		Distinguish between sand and pebble/rock beaches.	6.5
		Distinguish between pulp, pole, and saw timber in mixed stands.	6.7
		Detect small marine mammals (e.g., harbor seals) on sand/gravel beaches.	6.8
	7	Detect sea turtle trails between nest sites and the water.	7.4
		Detect large raptor (e.g., eagle, osprey) nests.	7.5
		Detect individual large waterfowl (e.g., snow goose, Canada goose, trumpeter swan) in previously harvested grain fields.	7.6
		Distinguish between alligators/crocodiles and fallen trees/logs on land.	7.6
		Identify floating objects as plastic garbage bags.	7.6
	8	Distinguish between whitetail deer bucks and does based on presence of antlers.	8.2
		Identify individual cattails.	8.3
		Determine occupancy of large raptor (e.g., eagle, osprey) nests.	8.3
		Identify tree species based on leaf size and shape.	8.4
		Distinguish between-oil-covered and unaffected seabirds.	8.5
		Distinguish between tree species based on bark texture.	8.5
		Identify neck bands on large waterfowl (e.g., snow goose, Canada goose, trumpeter swan).	8.6

NIIRS SCORING CRITERIA

- Agricultural Criteria -

LEVEL 1
Detect large (i.e., greater than 100 acre) slash and burn clearings in jungle areas. (NIIRS 1.4)
Identify long-lot land ownership patterns along major waterways. (NIIRS 1.7)

LEVEL 2
Detect forest clearings in suspected coca growing areas. (NIIRS 2.4)
Detect windbreaks (i.e., rows of trees) between fields. (NIIRS 2.6)
Detect forest clearings in suspected opium growing areas. (NIIRS 2.7)

LEVEL 3
Identify the path of a tornado through crop fields. (NIIRS 3.3)
Detect small (e.g., less than 1 acre) forest clearings in suspected opium growing areas. (NIIRS 3.3)
Detect individual large buildings (e.g., house, barn) in a farmstead. (NIIRS 3.3)
Detect slash and burn field abandonment in a jungle through observation of regrowth. (NIIRS 3.3)
Distinguish between crop land and pasture land. (NIIRS 3.4)
Detect hay mowing. (NIIRS 3.5)
Detect mechanized grain harvesting operations. (NIIRS 3.6)

LEVEL 4
Detect active plowing of fields. (NIIRS 4.1)
Identify small water sources (e.g., stock ponds, prairie potholes) in range land areas. (NIIRS 4.2)
Distinguish between individual trees in an orchard. (NIIRS 4.4)
Distinguish between individual rows in a mature vineyard. (NIIRS 4.5)
Detect large farm equipment (e.g., tractors, combines) in open fields. (NIIRS 4 5)
Identify commercial greenhouses. (NIIRS 4.6)
Detect marijuana harvest based on the absence of vegetation in known marijuana fields. (NIIRS 4.8)
Detect vehicle tracks through freshly plowed fields. (NIIRS 4.8)

LEVEL 5
Detect individual large domesticated animals (e.g., horses, cattle) in grazing pastures. (NIIRS 5.3)
Detect small (i.e., less than 1-meter wide) irrigation/drainage ditches. (NIIRS 5.3)
Identify individual bales of hay/straw. (NIIRS 5.4)
Distinguish between livestock watering troughs and feed troughs in pastures. (NIIRS 5.7)
Distinguish between individual rows of truck crops. (NIIRS 5.7)
Distinguish between livestock semi-trailers and regular box-body semi-trailers. (NIIRS 5.8)
Identify ornamental tree nurseries. (NIIRS 5.8)

- Agricultural Criteria – (Concluded)

LEVEL 6

Detect a closed gate across a single lane road. (NIIRS 6.0)
Identify orchards by fruit type based on tree size and shape (e.g., apple, cherry, citrus). (NIIRS 6.1)
Determine the number of rows on a field crop (e.g., corn, soybean) planter. (NIIRS 6.3)
Detect mixed cropping in small farm plots. (NIIRS 6.4)
Distinguish between mature and immature coca fields. (NIIRS 6.5)
Detect coca harvest based on the absence of leaves on coca bushes in known coca fields. (NIIRS 6.6)
Identify cattle guards on single lane roads. (NIIRS 6.6)
Detect the presence of obstructions (e.g., weed growth, soil, stumpage) in an irrigation system. (NIIRS 6.6)
Detect manual coca plant eradication. (NIIRS 6.6)
Identify large farm animals by type (e.g., horses, cows). (NIIRS 6.7)
Identify tractor-drawn farm machinery by type (e.g., plow, sprayer, planter). (NIIRS 6.7)
Detect flowering of opium poppies in known fields. (NIIRS 6.7)
Count sheep or goats in a flock. (NIIRS 6.8)
Identify silage crops by type (e.g., corn, sorghum). (NIIRS 6.9)
Distinguish opium poppies from wheat in small plots. (NIIR5 6.9)

LEVEL 7

Identify medium farm animals by type (e.g., sheep, goats). (NIIRS 7.1)
Identify individual steel fence posts. (NIIRS 7.6)
Distinguish between ewes and lambs. (NIIRS 7.7)
Distinguish between individual tea and coffee plants. (NIIRS 7.9)

LEVEL 8

Identify an uncoiled garden hose lying on the ground. (NIIRS 8.2)
Identify specific type of truck crop being grown (e.g., tomatoes, peppers, lettuce). (NIIRS 8.2)
Detect scoring of poppy bulbs. (NIIRS 8.5)
Detect tubing (approximately 1-inch diameter) for drip irrigation systems. (NIIR5 8.5)

Civil NIIRS Reference Guide

- Cultural Criteria -

LEVEL 1

Detect lines of transportation (either road or rail, but do not distinguish between). (NIIRS 1.3)
Detect major highway and rail bridges over water (e.g., Golden Gate, Chesapeake Bay). (NIIRS 1.7)
Detect multi-lane divided highways (e.g., greater than four lanes). (NIIRS 1.9)
Detect a golf course. (NIIRS 1.9)

LEVEL 2

Identify major street patterns in urban areas. (NIIRS 2.3)
Identify large POL storage tanks. (NIIRS 2.5)
Identify individual city blocks in a metropolitan area. (NIIRS 2.6)
Identify large buildings as multi-wing. (NIIRS 2.7)
Detect a dual lane/track bridge over water. (NIIRS 2.7)
Detect large area groundbreaking or clearing for construction of new facility or expansion of existing facilities. (NIIRS 2.7)
Identify vessels of ~300' length by type (e.g., merchant, combatant) at a known port. (NIIRS 2.8)
Detect rail yards of six or more tracks. (NIIRS 2.9)
Detect two-lane improved roads. (NIIRS 2.9)
Detect large UAS (e.g., Boeing 737, Airbus A-300, MD-80) at a major commercial airport. (NIIRS 2.9)

LEVEL 3

Detect two-lane unimproved roads. (NIIRS 3.0)
Detect cleared security strip around a sensitive facility. (NIIRS 3.1)
Detect trail clearing/cutting in forested areas. (NIIRS 3.1)
Detect land-based oil exploration activity (e.g., bore-holes/spoils, seismic survey traces) in an arid environment. (NIIRS 3.2)
Identify an off-shore oil exploration drilling vessel. (NIIRS 3.3)
Detect indications of underground mining activity (e.g., headworks, tailings, rail spurs). (NIIRS 3.3)
Detect new oil drilling sites in or near a known oil field. (NIIRS 3.3)
Distinguish between roads with single and multiple lanes. (NIIRS 3.3)
Identify a road as divided or undivided. (NIIRS 3.3)
Detect very large vehicles (e.g., tractor-trailers). (NIIRS 3.3)
Detect major breaks in lines of communications (e.g., collapsed bridges, washed out roads, inundation) due to natural disasters. (NIIRS 3.3)
Detect a nuclear reactor containment structure. (NIIRS 3.3)
Count all large free-standing smokestacks and/or cooling towers at major power plants. (NIIRS 3.3)
Detect rows of automobiles in a parking lot. (NIIRS 3.4)
Detect single rail cars on rail sidings. (NIIRS 3.5)
Detect fixed-wing UAS at a dirt or grass airstrip. (NIIRS 3.5)
Detect control tower at airfield. (NIIRS 3.5)
Detect slag heaps at a mineral processing plant. (NIIRS 3.5)
Identify individual greens on a golf course. (NIIRS 3.6)
Distinguish between individual rail cars in a train. (NIIRS 3.7)
Detect an automobile. (NIIRS 3.7)
Identify a small (e.g., less than 1/4 acre) electrical transformer yard in a residential neighborhood. (NIIRS 3.8)
Detect towers associated with power lines. (NIIRS 3.8)
Detect guard towers along perimeter fences. (NIIRS 3.8)

- Cultural Criteria – (Concluded)

LEVEL 4

Identify potential secondary fire sources (e.g., fuel storage areas, explosive storage area). (NIIRS 4.1)
Detect a security fence at an urban industrial facility. (NIIRS 4.1)
Detect barriers/obstacles (e.g., barrels, logs) on runways. (NIIRS 4.2)
Detect groups of cargo (e.g., crates, pallets) on piers and quays. (NIIRS 4.2)
Detect fallen trees obstructing two-lane roads. (NIIRS 4.4)
Distinguish between locomotives and rail cars. (NIIRS 4.6)
Detect external structural damage to urban buildings from natural disasters. (NIIRS 4.7)
Identify a pump house at an above ground POL (petroleum, oil, lubricant) storage area. (NIIRS 4.7)
Identify trucks as cab-over-engine or engine-in-front. (NIIRS 4.7)
Detect an individual concrete barrier/obstacle (e.g., dragon's teeth, Jersey barrier). (NIIRS 4.8)

LEVEL 5

Identify raw materials (e.g., lumber, sand, gravel, bricks) in a residential construction area. (NIIRS 5.0)
Identify individual lines painted on paved roads, aprons, parking lots. (NIIRS 5.1)
Distinguish between wheeled and tracked vehicle tracks. (NIIRS 5.1)
Identify large construction equipment by type (e.g., bulldozer, backhoe, road grader). (NIIRS 5.2)
Identify individual telephone/electric poles in residential neighborhoods. (NIIRS 5.4)
Identify fallen utility poles. (NIIRS 5.5)
Detect lines on track, basketball, volleyball, tennis, baseball, soccer playing areas. (NIIRS 5.5)
Identify individual 55 gallon drums in an open storage facility. (NIIRS 5.7)

LEVEL 6

Detect individuals, when not in a group. (NIIRS 6.2)
Identify pole-mounted electrical transformers in residential neighborhoods. (NIIRS 6.4)
Detect small road signs (e.g., stop, yield, speed limit) in an urban area. (NIIRS 6.6)
Identify building materials of urban structures (e.g., brick, wood, concrete, stucco, tile, adobe). (NIIRS 6.8)
Identify flags on a green at a golf course. (NIIRS 6.9)

LEVEL 7

Identify individual above ground utility lines in a residential neighborhood. (NIIRS 7.1)
Identify a manhole cover. (NIIRS 7.1)
Identify a fire hydrant. (NIIRS 7.2)
Identify limbs (arms, legs) on an individual. (NIIRS 7.3)
Distinguish between welded and riveted joints on large POL tanks. (NIIRS 7.6)
Identify riveting or seams on locomotives. (NIIRS 7.6)
Identify bicycle details (e.g., frame, wheel/tire, etc.). (NIIRS 7.7)
Detect outside rearview mirrors on passenger cars. (NIIRS 7.7)
Identify farm or construction tools by general shape (e.g., shovel, pitchfork, pick, ax, sledgehammer). (NIIRS 7.9)
Identify individual asphalt shingles on a residential roof. (NIIRS 7.9)
Count ceramic insulators on individual transmission wires at a switching yard. (NIIRS 7.9)

LEVEL 8

Identify valve locations along a small (~3") pipe. (NIIRS 8.0)
Detect corrosion on metal surfaces. (NIIRS 8.1)
Identify small hand tools (e.g., hammer, carpenters saw, pipe wrench). (NIIRS 8.1)
Identify hazardous material labels on crates and barrels. (NIIRS 8.1)
Identify the registration on pleasure craft in port. (NIIRS 8.1)
Determine the direction of flow through a pipe based on flow arrows. (NIIRS 8.2)
Identify facial features on an individual (i.e., at least partial discrimination of some facial features). (NIIRS 8.2)
Identify a cellular phone antenna on a passenger car. (NIIRS 8.2)

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- Natural Criteria -

LEVEL 1
Identify abandoned meander sections in major river flood plains. (NIIRS 1.4)
Detect large area (e.g., greater than 100 acres) timber clear cutting. (NIIRS 1.7)
Identify an inland delta, based on braided channels and oxbows. (NIIRS 1.8)
Detect large coastal sand beaches. (NIIRS 1.8)

LEVEL 2
Distinguish between islands and nests of moored ships. (NIIRS 2.2)
Detect utility towers in forested regions on the basis of a sequence of circular clearings. (NIIRS 2.7)

LEVEL 3
Identify general vegetation cover type (e.g., grass, brush, wetland, agricultural crop) in non-forested areas. (NIIRS 3.1)
Detect jeep trails. (NIIRS 3.3)
Identify small slash and burn agriculture plots (e.g., <1 acre). (NIIRS 3.5)
Identify inland waterways navigable by medium boats (e.g., 30' cabin cruiser). (NIIRS 3.5)
Detect small (e.g., less than 1 acre) man-made clearings in a forested area. (NIIRS 3.5)
Distinguish between open and closed forest canopies. (NIIRS 3.5)
Detect landslide or rockslide large enough to obstruct a single lane road. (NIIRS 3.6)
Distinguish between operational and abandoned quarries. (NIIRS 3.7)

LEVEL 4
Detect jeep trails in scrub brush. (NIIRS 4.1)
Distinguish between islands and mats of aquatic vegetation. (NIIRS 4.1)
Identify cable logging operations. (NIIRS 4.1)
Detect individual truck tracks through grassy vegetation. (NIIRS 4.3)
Detect vertical obstruction (e.g., tree, shrub, snag) in vegetated helicopter landing zones. (NIIRS 4.3)
Identify log decks (i.e., stacks of recently cut logs). (NIIRS 4.4)
Detect jeep trails crossing bare soil areas. (NIIRS 4.5)
Detect fallen trees in inland waterways. (NIIRS 4.9)

LEVEL 5.0
Identify hummocks in marsh/swamp. (NIIRS 5.0)
Detect selective timber harvest. (NIIRS 5.0)
Detect foot trails through grassland. (NIIRS 5.1)
Detect small marine mammals (e.g., harbor seals) on ice floes. (NIIRS 5.1)
Detect small water sources (e.g., springs, seeps) in arid areas. (NIIRS 5.2)
Distinguish individual trees in a closed canopy deciduous forest. (NIIRS 5.3)
Identify prairie dog towns based on soil disruption pattern. (NIIRS 5.4)
Detect evidence of a fish kill (e.g., masses of floating fish). (NIIRS 5.5)
Identify tree species on the basis of crown configuration. (NIIRS 5.5)
Detect large game (e.g., deer, antelope, elk, and moose) in a meadow. (NIIRS 5.6)

LEVEL 6
Detect natural objects (e.g., tree stumps, large rocks, boulders) in forest clearings and open fields. (NIIRS 6.2)
Distinguish between hummocks and stands of aquatic grass/cattails in marsh/swamp. (NIIRS 6.3)
Distinguish between pulp, pole, and saw timber in single species plantation stands. (NIIRS 6.3)
Detect schools of dolphins (e.g., Bottlenose, Dahl) in coastal waters. (NIIRS 6.5)
Distinguish between sand and pebble/rock beaches. (NIIRS 6.5)
Distinguish between pulp, pole, and saw timber in mixed stands. (NIIRS 6.7)
Detect small marine mammals (e.g., harbor seals) on sand/gravel beaches. (NIIRS 6.8)

- Natural Criteria - (Concluded)

LEVEL 7

Detect sea turtle trails between nest sites and the water. (NIIRS 7.4)
Detect large raptor (e.g., eagle, osprey) nests. (NIIRS 7.5)
Detect individual large waterfowl (e.g., snow goose, Canada goose, trumpeter swan) in previously harvested grain fields. (NIIRS 7.6)
Distinguish between alligators/crocodiles and fallen trees/logs on land. (NIIRS 7.6)
Identify floating objects as plastic garbage bags. (NIIRS 7.6)

LEVEL 8

Distinguish between whitetail deer bucks and does based on presence of antlers. (NIIRS 8.2)
Identify individual cattails. (NIIRS 8.3)
Determine occupancy of large raptor (e.g., eagle, osprey) nests. (NIIRS 8.3)
Identify tree species based on leaf size and shape. (NIIRS 8.4)
Distinguish between-oil covered and unaffected seabirds. (NIIRS 8.5)
Distinguish between tree species based on bark texture. (NIIRS 8.5)
Identify neck bands on large waterfowl (e.g., snow goose, Canada goose, trumpeter swan). (NIIRS 8.6)

APPENDIX B. SAMPLE FORMS.

Mission Data Sheet

Mission Number:	Date:
Mission Objectives:	
Criteria (If Applicable):	Land Time:
Take Off Time:	Land Time:
Collection Start Time (Change Detection):	Collection Stop Time (Change Detection):
Collection Start Time (Activity Monitoring):	Collection Stop Time (Activity Monitoring):
Flight Altitude:	Weather Conditions:
Target Types/Quantity:	Radar Mode:
Mission Findings/Comments:	
Technical Issues:	

SPOT REPORT (SPOTREP)

Use the SPOTREP to send information to provide timely intelligence or status regarding events that could have an immediate and significant effect on current planning and operations. The SPOTREP is a report containing information for which speed of transmission is essential. A SPOTREP does not have a prescribed format, but use of the SALUTE format could ensure reporting of essential information.

When reporting any intelligence information to Headquarters or other Units the S.A.L.U.T.E. format should always be used. This could ensure all information is accurate and complete: Size, Activity, Location, Unit, Time, and Equipment.

TO	**DATE/TIME of REPORT SUBMITTAL**
Line 1: SIZE *of enemy force. Report the number of personnel, vehicles, UAS, or size of an object.*	
Line 2: ACTIVITY *of the enemy. Report detailed account of actions, for example, direction of movement, troops digging in, artillery fire, type of attack, NBC activity, etc.*	
Line 3: LOCATION *of Enemy Activity or Event Observed. Report where you saw the activity UTM or Six-Digit Grid Coordinate with MGRS Grid Zone Designator. Include grid coordinates or reference from a known point including the distance and direction from the known point.*	
Line 4: UNIT *Identification. Report the enemy's unit. If the unit is unknown, report any distinctive features, such as uniforms, patches or colored tabs, headgear, vehicles, identification/ markings/symbols, agency markings, etc.*	
Line 5: TIME *Report the time the activity was observed, not the time you report it. Always report local or Zulu time.*	
Line 6: EQUIPMENT *Report all equipment associated with the activity, such as weapons, vehicles, tools. If unable to identify the equipment, provide as much detail as you can so an identification can be made by higher headquarter (include: type weaponry, web gear, electronics, night vision, body armor, vehicles, tents, etc.).*	
Line 7: SENDER's ASSESSMENT *Specific Sender Information.*	
Line 8: NARRATIVE *Free Text for additional Information Required for Clarification of Report not included in the SALUTE format.*	
Line 9: AUTHENICATION *Report Authentication.*	
Line 10: RECEIVED BY *Name, Position.*	

APPENDIX C. LASER DESIGNATION ACCURACY DATA ANALYSIS EXAMPLE.

C.1 A VBLSS is an instrument that can be used to determine the impact point for each of the laser pulses scored. A video camera specially configured to capture the laser spot is trained on the laser target board, and the laser spot is recorded for each designation trial (see Figure C.1-1, 2). With the VBLSS or similar system, digitize the recorded laser spot video, determine the centroid of each laser pulse, and calculate x-y data relative to the center of the target being tracked. These x-y measurements for each laser pulse form the basis of the data set used to analyze laser designation performance.

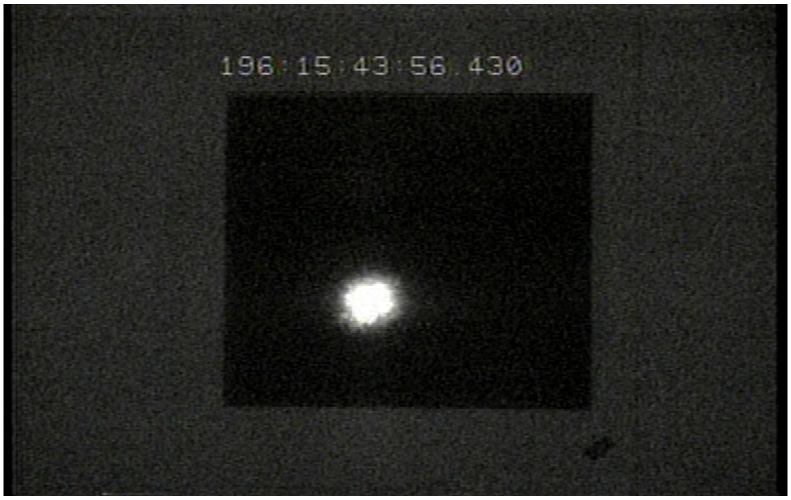

FIGURE C.1-1. Sample Recorded Laser Spot for VBLSS Processing

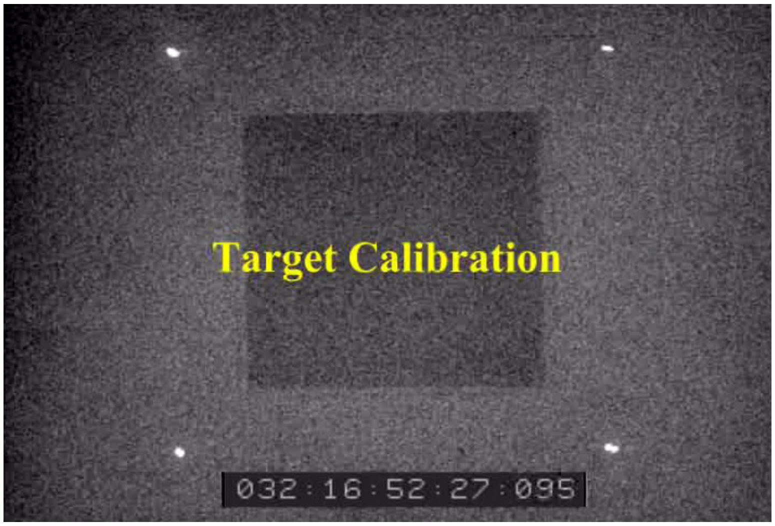

FIGURE C.1-2. Sample Recorded VBLSS Calibration Frame

The data for a single 20-second laser designation trial can be presented as a time history for each axis. A sample is shown in Figures C.1-3 and C.1-4.

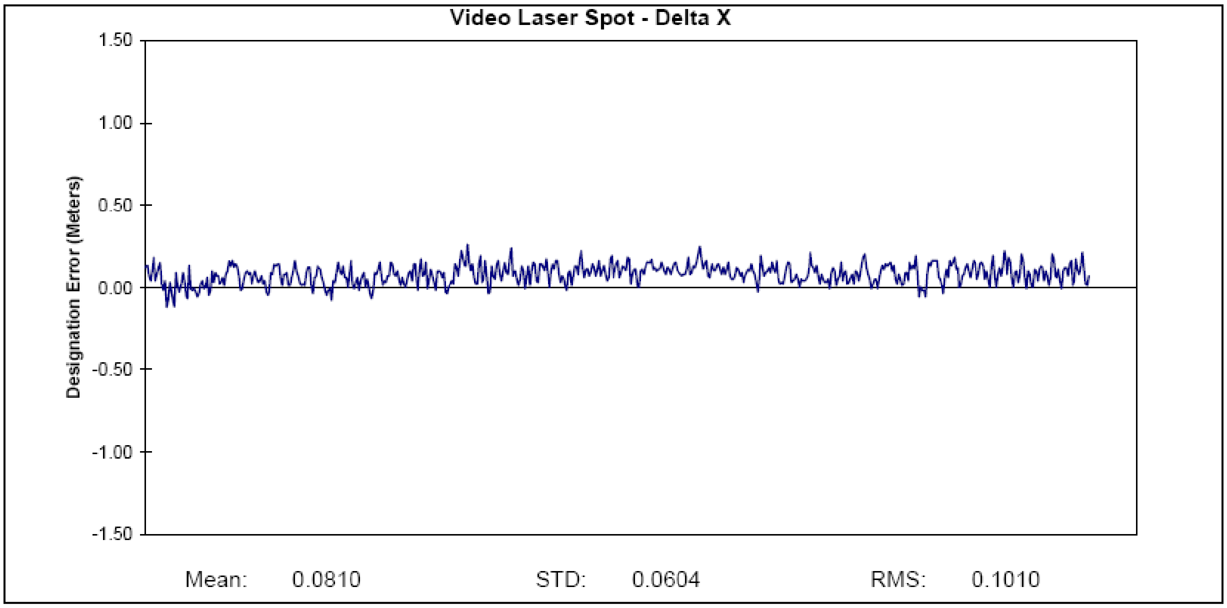

FIGURE C.1-3. Sample Time History of Laser Centroid, X-Axis
(Typical 20-Second Designation)

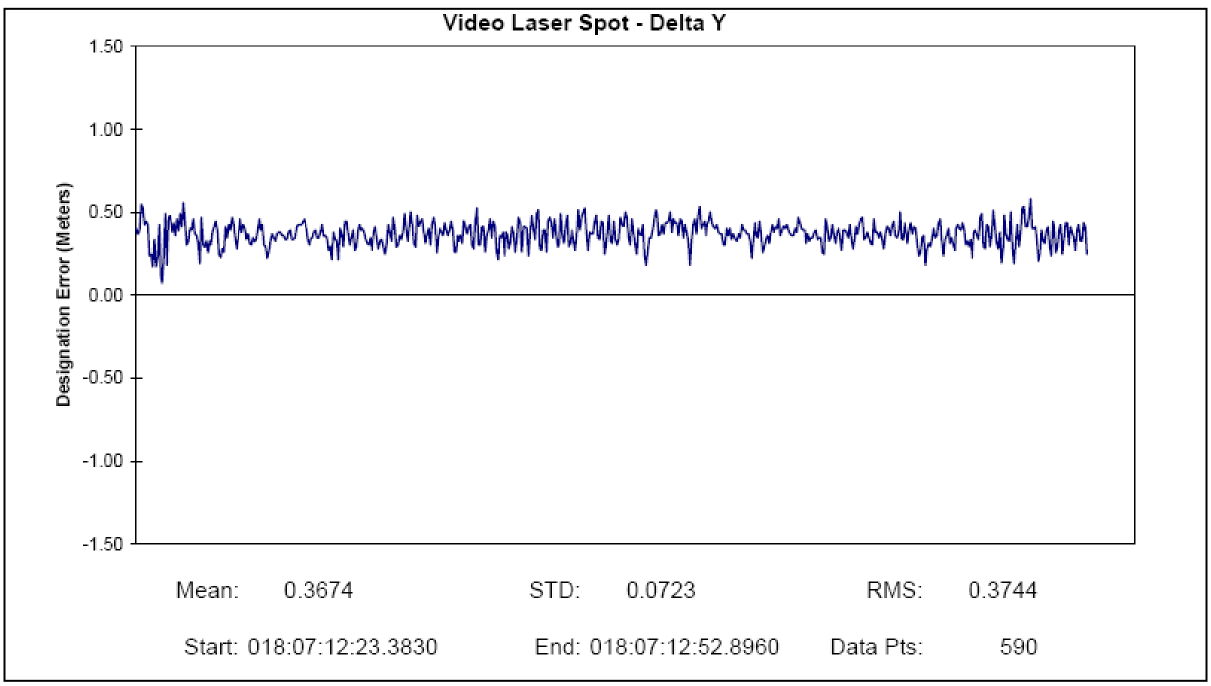

FIGURE C.1-4. Sample Time History of Laser Centroid, Y-Axis
(Typical 20-Second Designation)

The above sample plots are demonstrative and show the boresight adjustment error (the mean error from center) as well as the tracker stability (the standard deviation). The combination of the error is captured in the Root-Mean-Square (RMS) value. For the example illustrated in Figures C.1-3 and C.1-4, the VBLSS collected data on 590 laser pulses. The system shows a boresight adjustment error in the y-axis but the x-axis is aligned well. Individual trials can be analyzed and or the passes can be summarized as shown in Figure C.1-5 to access overall performance with measures such as total pointing error (TPE), etc. Each pass consists of one 20-second designation (approximately 400 to 600 laser pulses).

Flight # 11
Test Date: 17 Jan 2006

Pass #	X Mean	X STD	X RMS	Y Mean	Y STD	Y RMS
48B	0.0332	0.0740	0.0810	0.4542	0.0963	0.4642
48C	0.0563	0.0657	0.0865	0.4866	0.0921	0.4952
48D	0.0676	0.0683	0.0961	0.5290	0.1007	0.5384
55A	0.0643	0.0615	0.0890	0.3728	0.0832	0.3819
55B	0.0742	0.0629	0.0972	0.3847	0.0813	0.3932
55C	0.0810	0.0604	0.1010	0.3674	0.0723	0.3744
61A	0.0477	0.0747	0.0886	0.5275	0.1547	0.5497
61B	0.0354	0.0717	0.0799	0.3526	0.0953	0.3652
61C	0.0326	0.0765	0.0830	0.3432	0.0939	0.3558

FIGURE C.1-5. Sample Laser Designation Trials Summary
(Each Pass is a 20-Second Designation)

APPENDIX D. ABBREVIATIONS.

AGL	Above Ground Level
CACTIS	Compacted Automated Centroid Target Instrumentation System
CCR	Corner Cube Reflectors
CTV	Color TV
DTC	Developmental Test Command
EO	Electro-Optical
FEBT	Field Equivalent Bar Target
FLIR	Forward-Looking Infrared
FOR	Field-of-Regard
FOV	Fields-Of-View
GMTI	Ground Moving Target Indicator
GPS	Global Positioning System
HAT	Height Above Target
HP	Hover Point
IAT	Image Auto Track
IAW	In Accordance With
INS	Inertial Navigation System
IPR	Impulse Response
IR	Infrared
LD	Laser Designation
LOS	Line Of Sight
LRF	Laser Rangefinder
MDV	Minimum Detectable Velocity
MRGSD	Minimum Resolvable Ground Sample Distance
NFOV	Narrow Field of View
PD	Probability of Detection
PID	Probability of Identification
SAR	Synthetic Aperture Radar
SPOTREP	Spot Report
SUT	System Under Test
TBD	To Be Determined
TEMP	Test and Evaluation Master Plan
TLE	Target Location Error
TOC	Tactical Operations Center
TOP	Test Operations Procedure
TSPI	Time, Space, Position Information
UAS	Unmanned Aircraft System
UNFOV	Ultra Narrow Field of View
UTM	Universal Transverse Mercator
VBLSS	Video-Based Laser Scoring System
VRT	Vertical Reference Target
WFOV	Wide Field of View

APPENDIX E. REFERENCES.

1. TOP 06-2-040, Non-Lethal Unmanned Aerial Vehicles (UVs), 15 June 1993

2. TOP 07-1-001, Unmanned UAS Systems (UAS) Testing Overview, TBD

3. International Test Operations Procedure (ITOP) 06-3-041, Field Measurement DRI Ranges for Thermal Imaging Systems (Ground Based Targets), 9 December 2003

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Test Business Management Division (TEDT-TMB), U.S. Army Developmental Test Command, 314 Longs Corner Road, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Aviation and Air Delivery Systems Division (TEDT YPY AV), 301 C Street, Bldg. 3021, Yuma, AZ 85365-9498. Additional copies can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6217. This document is identified by the accession number (AD No.) printed on the first page.